APPLIED ANATOMY AND PHYSIOLOGY

EVH 110 **Credits – L:T:P = 4:0:2** **CIE: 50 Marks**
Hours/Week: 4(L) +2(P) **SEE: 100 Marks**

Course Objective

The course is unique as it encompasses medical knowledge dealing with anatomy and physiology of human body. Discusses the human cells, tissues, organs and topography for an engineering student. It also covers body functions of different systems. Deals with special sensory organs and their structure and functions. Course emphasizes on the pollutants' uptake, their magnification in some organs and their conversion aspects.

At the end of the course the students will be able to:

CO1: Draw and identify the different parts of human body. Isolate different organ systems.
CO2: Discuss blood circulatory system, identify the common heart diseases. Clearly describe the respiratory system of human body and list the important diseases affecting lungs.
CO3: Explain the central nervous system and neurological disorders. Illustrate joints and muscles of human body. List the diseases associated with human bone architecture.
CO4: Identify and explain the functions of different gland systems of human body. Describe the common endocrine diseases. Distinguish different components of human digestive system and explain their functions.
CO5: Identify both external and internal genital systems of human body. Explain their functional relationship and sex determination. Differentiate sensory organs of human body and illustrate their functions and associated diseases.

Content	Hours
Introduction to human body: Cell - tissues – organs – systems, Postures, terms, division of the human body. Topography. Fate and transport of pollutants in human body.	07
Body Systems and their Functions: Blood and circulatory system - Heart blood vessels, Circulations. Common diseases of Heart & Blood vessels	07
Respiratory system: Nose, Pharynx, larynx, Trachea, Tracheobroncheal tree, lungs, thoracic cavity, respiratory membrane, gaseous exchange, important diseases affecting lungs	08
Central Nervous System: Nerves, Brain, Spinal Cord, Autonomic Nervous System. Neurological diseases.	07
Locomotor System: Joints and muscles, bone architecture	07
Endocrine glands: Pituitary, Thyroid, Parathyroid, adrenal, and Endocrine Pancreas. Names of the hormones and functions. Common endocrine disorders.	06
Digestive System: Mouth, Pharynx, Oesophagus, stomach, liver and pancreas, Small intestine, large intestine. Digestion, absorption, and motility functions.	10
Genito-urinary System: Urine forming organs-Kidneys, uterus, urinary bladder, prostate, urethra, Organs involved in the process of procreation, sex determination, external genital organs and internal genital organs.	10
Special sense organs: Skin, eyes, nose, ears & tongue	03

Total	**65**

TEXT BOOKS

- Anne Waugh, Allison Grant, and Janet S. Ross, (2001),"Rossand Wilson – Anatomy and Physiology in Health and illness" – 9th Edition , Churchill Livingstone
- Jain A.K., (2002), "Human Anatomy & Physiology", Arya Publications

REFERENCES

- Anne B. Donnesberger, (2011), "A Laboratory Text Book of Anatomy and Physiology", Jones and Bartlett Publishers.

APPLIED MICROBIOLOGY AND PUBLIC HEALTH

EVH 120 **Credits – L:T:P = 4:0:2** **CIE: 50 Marks**
Hours/Week: 4(L) + 2(P) **SEE: 100 Marks**

Course Objective

The course lays the foundation for applying microbiological knowledge in maintaining public health. It deals with microbial species identification, determination. It describes structural, morphological and functional aspects of microorganisms. The course covers microbial physiology including metabolism and its influencing parameters. The course provides the knowledge on public health, epidemic and endemic diseases and their control. It also helps student to gain knowledge on microbial immunology.

At the end of the course the students will be able to:

CO1: Discuss prokaryotes and eukaryotes. Identify and characterize different microorganisms of medical importance
CO2: Perform different staining techniques to identify and enumerate different microbial species
CO3: Describe and draw structure and functional relationships of different microbial cells such as bacteria, fungi, algae and virus
CO4: Calculate microbial nutrients requirement. Understand and prepare different culture media requirements for microbial species growth. Explain microbial growth curve and factors influencing it. List epidemic and endemic diseases and discuss the cause effect relationship.
C05: List and review methods of control of infectious diseases caused by microorganisms. Describe the function of immune system and its response

Content	Hours
Introduction: Scope and relevance of microbiology, History of microbiology, Prokaryotes and Eukaryotes, Types of microorganisms	04
Microbiological Techniques: Pure culture, staining of microorganisms, enumeration of microorganisms and sterilization techniques	08
Structure, Function, Reproduction and characterization of Microorganisms Bacteria – morphology, structure and reproduction. Virus – morphology. Classification, lytic and lysogenic cycles**,** Fungi – morphology, structure and reproduction	10
Microbial Physiology: Microbial nutrition – common nutrient requirements and culture media, Microbial growth: Growth curve, Generation time, factors affecting growth, measurement of growth, simple problems	15
Public Health and Medical Microbiology Public Health Hygiene, Epidemic, Endemic and Pandemic Diseases and their control. Common microbial diseases and their control, bacterial – typhoid, tuberculosis, cholera, leprosy, syphilis and diarrhea. Viral – AIDS, Hepatitis, Ebola, SARS, MERS, Polio, Rabies, COVID Fungal – Candidiasis, mycoses Protozoa – Amoebiosis, Giardiasis, Cerebral Malaria, Helminthesis.	20
Immunology: Structure and function of immune system, Antigen & Antibody, Immunity, Infection, Immune response.	08
Total	**65**

TEXT BOOKS

- E.C.S. Chan,Michael J. Pelczar, Jr.,and Noel R. Krieg, (2004), Microbiology, 5th Edition or later , Tata McGraw-Hill Education Pvt. Ltd.
- Stanier, R. Y., Ingraham, J. L., Wheelis, M. L. and Painter, P. R. (2005). General Microbiology. 5th edition McMillan Press Ltd.

REFERENCES

- Anthony F Gaudy, Jr. and Elizabeth T Gaudy (1980), "Microbiology for Environmental Scientists and Engineers", McGraw Hill.
- Chakraborthy P(2005), "Textbook of Microbiology", 2nd Edition, New Central Book Agency Pvt. Ltd.,
- Ananthanarayan and Paniker (2020), "Textbook of Microbiology", 11th edition, Universities Press (India) Pvt. Ltd

DESIGN OF WATER TREATMENT PROCESSES AND DISTRIBUTION SYSTEM

EVH 130 **Credits – L:T:P = 3:2:0** **CIE: 50 Marks**

Hours/Week: 3(L) + 2(T) **SEE: 100 Marks**

Course Objective

The course covers the details of design considerations of various unit operations and processes of Water treatment facilities and distribution systems. High lights the importance of water quality requirements for health care facilities. Provides the laboratory exposure to analyze various water quality parameters and processes.

At the end of the course the students will be able to:

CO1: Explain the inter-relationship between water quality parameters and plant sizing, hydraulics and layout. Design intake structures.
CO2: Describe and design aeration, sedimentation, coagulation and flocculation processes. Explain settling equations. Tube settlers and pulsators.
CO3: Design filter units, filter backwash system. Discuss the chemistry and kinetics of disinfection. Understand and apply the knowledge of isotherms in adsorption process
CO4: Design miscellaneous treatment processes such as softening, fluoridation / defluoridation. Explain the removal process for trace contaminants.
CO5: Develop a protocol for health care water requirements. Describe the norms and different rural water supply schemes. Explain need for industrial water quality requirements.

Content	Hours
Introduction: Water sources characteristics and quality parameters, standards and guidelines. **Design considerations** for Plant sizing and layout, hydraulic flow diagram.	9
Hydraulics of conduits - Intake structures – types, design, rising main and water hammer analysis pump design,	4
Aeration – principles and design of aeration systems – two film theory.	2
Coagulation and Flocculation – types of coagulants, coagulant aid, coagulation theory, optimum dose of coagulant, design of clariflocculator with flash mixers.	6
Sedimentation – types of settling and settling equations (Stoke's, Newton's, & Transition), design of settling tanks; Operational problems. Tube and plate settlers and pulsators, DAF units.	8
Filtration – theory, types, hydraulics of filter bed, design of filter units, filter backwash, operational problems and trouble shooting.	5
Adsorption – types, equilibrium kinetics and Isotherms and problem solving.	4
Disinfection - Disinfectants, influencing factors, methods, byproducts and kinetics. Alternate disinfection processes.	4
Health Care water quantity/ quality requirements, Industrial and rural water supply systems. Public health signifance of cross connections, public health issues of drinking water cleanliness.	6
Water distribution systems – Hardy Cross and Newton, Raphson's methods – numerical problems, sectioning, relaxation and pipe equivalence. Dual water supply system, cleanliness of water distribution system, WQM&S	9

Miscellaneous treatment: Water Softening, defluoridation processes, specific/ trace organic contaminants – Arsenic (As), desalination, natural organic matter (NOM), dissolved organic matter (DOM), and Nitrate removal. Medical materials in drinking water, Dual water supply system	8

Total	**65**

TEXT BOOKS

- Fair, G.M., Geyer J.C and Okun, (1969) "Water and Waste water Engineering" Vol II, John Wiley Publications.
- Weber W.J., (1975) "Physico - Chemical Processes for Water Quality Control".

REFERENCES

- AWWA, (1971), "Water Quality and Treatment McGraw Hill.
- CPHEEO Manual, (1991), "Water Supply and Treatment", GOI Publications.
- Peavy, H.S., Rowe and Tchobonoglous, G., (1985), "Environmental Engineering", McGraw Hill.
- APHA, 2005, Standard methods for examination of water and wastewater, 21st Edition.

PHYSICO-CHEMICAL TREATMENT PROCESSES LAB

EVH 170 **Credits – L:T:P = 0:0:1.5** **CIE: 50 Marks**
Hours/Week: 3 Hrs/Week

Course Objective
The lab course provides an opportunity to collect and preserve water samples from different sources, conduct various tests on water quality parameters, perform experiments on selected lab scale treatment processes. It also enriches the student knowledge of determining coagulant dose, efficiency of settling basin, rate of adsorption and life of adsorbent. The lab course also exposes the student to various advanced instruments used in analyzing toxic chemicals and trace organics in water and wastewater.

At the end of the course the students will be able to:

CO1: Acquaint with precision and accuracy of analytical data and to appreciate rounding off to a significant value in the context of water quality parameters. Apply various methods of sample preservation and conduct titrimetric and instrumental analyses on water samples
CO2: Carryout and determine treatment efficiency of various water treatment processes – aeration, jar test for optimum dose of coagulant and settling experiments, adsorption experiments with isotherms and break through curve
CO3: Plan and perform filtration experiments, understand the significance of break point chlorination and plot particle size distribution curve, determine Uniformity coefficient. Develop the skill of analysing, interpreting and inferring the laboratory data

Experiment	Hours
Titrimetric and Instrumental Analyses of Water Quality Parameters – Ground and Tap Water Samples	06
Determination of Chlorine Demand for a given water sample and to plot the Break Point Chlorination Curve	06
Determination of Optimum Coagulant Dose using Jar Test Apparatus for given water samples	03
Conducting Settling Experiments and identify Type 1 and Type 2 settling and determination of settling efficiency	06
Performing Sieve Analysis for Filter Sand samples	06
Carrying out experiments on Single and Multimedia Filters and Head Loss calculation	06
Conducting Adsorption Experiments using Activated Carbon and plotting of Isotherm and Breakthrough Curve	06
Demonstration of Advanced Instruments such as ICP, UV-VIS Spectrophoto-meter, HPLC	03
Total	**42**

REFERENCES

- American Public Health Association, American Water Works Association, (1998), Standard Methods for Examination of Water and Wastewater, 20th edition, APHA.
- NEERI, Nagpur, “Water Quality Analysis Manual”.
- Bureau of Indian Standards (BIS) Codes

HUMAN RESOURCE MANAGEMENT IN HEALTH CARE AND ETHICS
(ELECTIVE I)

EVH 141 **Credits – L:T:P = 4:1:0** **CIE: 50 Marks**
Hours/Week: 4(L) + 1(T) **SEE: 100 Marks**

Course Objective
The course transmits the knowledge of basics of management, management strategies to be adopted in a work place. Discusses health work place policy, code of practice in hiring health care workers. It also provides the detailed information regarding types, levels and functions of management. Describes the SWOT analysis and its importance. It deals with personnel management and communication skills to be developed. It covers ethics in detail including professional, personal, medical and research ethics.

At the end of the course the students will be able to:

CO1: Define, classify and identify the functions of management. Perform SWOT analysis for a given situation.
CO2: Deal with different types of persons at a work place with managerial skills and style of management. Develop leadership qualities and establish good relationship between the employer and the employee. Practice time management
CO3: Develop good communication skills and eliminate barriers of communication, if any. Review health care policy and human resource relationship strategies. Implement good and cordial relationship amongst the health care workers and administrators.
CO4: Discuss the national and international codes of practice for health care workers employment. Describe the pros and cons of health care tourism. Differentiate ethics and ethical practices between individuals and human life.
CO5: Know the depth of medical ethics, family and society in medical ethics. Identify the responsibilities of individuals. Distinguish between professional and research ethics.

Content	Hours
Management Basics & Strategies Management - definition, functions, classification, coordination, types and levels, TOWS matrix	10
Personnel Management Motivation–importance and need, Maslow Theory, pre-requisites. Time and man management, Employee-employer relationship, leadership styles and situational model, leadership qualities.	10
Communication – elements and objectives, characteristics, barriers, (verbal & non verbal), downward & upward, factors and soft skills.	10
Health workplace policy and Planning Human Resources for Health (Health workforce) - Doctors, Specialists, Super Specialists, Nurses, Paramedics, Health Workers	10
Global Code of Practice on the International Recruitment of Health personnel Health Care tourism	10
Ethics Ethics in general, Introduction to medical ethics-.Definitions & perceptions	15

Ethics of Individuals, Ethics of Human life, Family & society in Medical Ethics, Death & dying Professional Ethics, Research Ethics, Hippocratic oath & declaration of Helsinki Responsibilities of individuals	
Total	**65**

TEXT BOOKS

- Schermerhorn J.R., (2010), "Introduction to Management", Tenth Edition, International Student Version, John Wiley and Sons Inc., UK
- Francis C.M., (2004), "Medical Ethics", Jaypee Brothers Medical Publishers (P) Ltd., New Delhi
- Joshi D.C., and Mamta Joshi, (2009), "Hospital Administration", 1st Ed., Jaypee Brothers Medical Publishers

REFERENCES

- World Medical Association, (2005), "Medical Ethics Manual"
- Joshi S.K. (2014), "Quality Management in Hospitals",2nd Revised Ed., Jaypee Brothers Medical Publishers
- Prabhakar G.V., (),"Short text book of Professional Medical Ethics"

ADVANCED WATER RESOURCES ENGINEERING
(ELECTIVE I)

EVH 142 **Credits – L:T:P = 4:1:0** **CIE: 50 Marks**
Hours/Week: 4(L) + 1(T) **SEE: 100 Marks**

Course Objective

The course emphasizes computational aspects of advanced hydrology and provides scientific approach to several important applications in hydrologic engineering.

At the end of the course the students will be able to:

CO1: Recognize and explain the distribution, availability, significance, and multiple uses of water resources at regional, national, and global scale; apply techniques to measure the components of hydrologic cycle
CO2: Explain watershed concepts, apply hydrograph theory in estimating overland runoff
CO3: Explain various methods of measuring flow in a stream and analyze for low flow. Apply statistical methods and tools for hydrologic data analysis
CO4: Simulate hydrological response of a watershed using watershed models. Demonstrate the Applications of remote sensing and GIS in water resource management
CO5: Model the groundwater flow in confined and unconfined aquifers under steady and unsteady state conditions

Content	Hours
Water Resources and issues- global, national, and regional and significance; National water policy, Riparian rights; Multiple uses of water resources, importance of hydro projects and its environmental problems.	08
Hydrologic principles: Hydrologic cycle – precipitation – types and measurement, ID and IDF curves, PMP and PMF; infiltration, evaporation, ET – factors affecting and measurement techniques	07
Hydrologic analysis: Watershed concepts, rainfall-runoff estimation, unit hydrograph theory, S-hydrograph, synthetic and instantaneous UH and their applications	08
Stream gauging: Weirs and flumes, A-V method, slope-area method, chemical and radioactive method, advanced techniques	07
Stream flow routing: Lumped flow, distributed flow, kinematic wave model, Muskingum method, low flow analysis	05
Hydrologic statistics: Statistical analysis of hydrologic data, key statistical measures, probability distributions, parameter estimation methods – moments, weighted moments & L –moments, maximum likelihood, least squares Hypothesis testing	10
Hydrologic simulation models – Steps in watershed modeling, major watershed Models – working philosophy, input data requirements, outputs, limitations	04
Remote Sensing and Geographical Information System in water resources engineering: assessment of ground water potential, flood plain/risk mapping, soil moisture studies, integrated water management studies	08
Ground Water: Aquifer properties, basic equations of flow, steady and unsteady flow into wells, well loss and interference among wells.	08
Total	**65**

TEXT BOOKS

- Subramanya K (2020), "Engineering Hydrology", 5 t h Edition, Tata McGraw HillPublishing Company Ltd., New Delhi
- Raghunath H. M., (2015), "Hydrology: Principles, Analysis, and Design", 3rd Edition, New Age International Publishers

REFERENCES

- Jayarami Reddy P (2016), "A Text Book of Hydrology", 3rd Edition, University Science Press, Lakshmi Publications Pvt. Ltd., NewDelhi
- Ven Te Chow (1964), "Handbook of Applied Hydrology: A Compendium of Water Resources Technology", Vol 1, McGraw Hill
- Tim Davie, (2019), "Fundamentals of Hydrology, 3rd Edition, Routledge. Taylor andFrancis Group, London, New York
- Todd D. K., and Mays L.W. (2005), "Groundwater Hydrology", Third Edition Wiley Eastern Publication, New Delhi

TRANSPORT PROCESSES AND MODELLING
(ELECTIVE I)

EVH 143	**Credits – L:T:P = 4:1:0**	**CIE: 50 Marks**
Hours/Week: 4(L) + 1(T)		**SEE: 100 Marks**

Course Objective

The course emphasizes on various transport processes and illustration of mathematical models in simulation and prediction of pollutant concentration, and dispersion in surface and subsurface water bodies.

At the end of the course the students will be able to:

CO 1: Know the simulation models for predicting fate and transport of pollutants with examples. Describe and differentiate the transport processes of advection and convectionprocesses and derive related equations with analytical solutions.
CO 2: Apply mathematical models and predict pollutant (conservative and non-conservative) concentrations in lakes and rivers under steady-state conditions; solve simple numerical problems.
CO 3: Describe the concept of mixing zone in natural aquatic bodies and its influence on pollutant dispersion; prepare field monitoring protocol for measuring hydraulic as well water quality parameters.
CO 4: Compare stratified and completely-mixed lake systems; describe mathematical equations to compute pollutant distribution in lake and estuarine systems. Design outfall system for ocean disposal.
CO 5: Derive and apply 1-D groundwater model considering the influencing processes, field validation. Demonstrate the application of different prediction models for quality predictions and decision making.

Content	Hours
Modelling – Introduction, applications in environmental management.	02
Physical phenomena – advection, diffusion, dispersion, Fick's laws of diffusion, convective - diffusion equations for turbulent & shear flow regimes.	08
Steady-state water quality modeling - models for conservative and non-conservative substances.	06
1-D Oxygen balance models - Streeter-Phelps equation, critical point method. Calibration and verification of 1-D oxygen model. Error measures.	08
Data collection and analysis - specialized water quality surveys, estimation of decay and reaeration rates.	06
Mixing zones in rivers – types of outfalls and mixing regimes. Stream tube concept, Steady-state 2-D analysis. Parameter estimation - lateral mixing coefficient - critical point method, Case studies.	07
Dissolved oxygen models for lakes under completely mixed and stratified conditions.	06
Estuaries – Salinity distribution and its importance on flora and fauna.	08
Ocean - disposal of wastewater - siting and design of outfalls.	06
Ground water quality modeling concepts - formulation of 1-D and 2-D models with decay and retardation for instantaneous sources, plume delineation studies. **Lab Component**	08

• River Water Quality Prediction Models – STREAM, QUAL2KW, MIXING ZONE Models • Data Analysis Models • IA 2D PIT • Prediction Models for estuary, lake and ocean using excel spreadsheet	
Total	**65**

TEXT BOOKS

- Thomann R.V., and Mueller J.A., (1987), "Principles of Water Quality Management and Control", Harper & Row Publications.
- Schnoor J.L., (1996) "Environmental Modeling – Fate and Transport of Pollutants in Water, Air and Soil", John Wiley and Sons.

REFERENCES

- Rich L.G., "Environmental Systems Engineering", McGraw Hill.
- Thomann R.V., (1980), "Systems Approach to Water Quality Management", McGraw Hill.
- Lee C.C., and Lin S.D., (1999), "Handbook of Environmental Engineering Calculations", McGraw Hill, New York.
- Metcalf and Eddy Inc., (1995), "Wastewater Engineering - Treatment and Reuse", 3RD Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

OCCUPATIONAL SAFETY AND HEALTH
(ELECTIVE II)

EVH 151 **Credits: L:T:P = 4:1:0** **CIE: 50 Marks**
Hours/Week: 4(L) + 1(T) **SEE: 100 Marks**

Course Objective

This course enables student to learn the basic principles of safety, OSH act and the national policy. It instills knowledge on cause - effect relationships of accidents at work places, need for economics & ergonomics, hazard identification and control aspects, fire prevention and control. Work place health related issues are also covered.

At the end of the course the students will be able to:

CO1: Develop knowledge on safety principles, right-to-know laws and manage situation applying theories of accident at workplace
CO2: Develop skill of understanding the ergonomics and address specific problems with appropriate strategies
CO3: Identify and analyze the hazards using various techniques and prepare preventive plans. Also, discuss the hazards in selected industries and suggest remedial measures for their control
CO4: Describe the need for product safety and its importance and acquire knowledge on various aspects of fire - types, prevention, protection and control
CO5: Know the Biomedical Waste (Handling and Management) Rules and develop a protocol for biomedical waste collection, transport and disposal. Acquire in depth knowledge of Health and Safety Considerations at different work places with a thorough understanding of preventive and control techniques.

Content	Hours
Introduction to Occupational Health, Occupational Hazard and control Principles of Safety and safety triangles, National Safety Policy. Occupational safety and Health Act (OSHA), Occupational Health and Safety administration - Laws governing OSHA and right to know.	08
Accident – causation, investigation, investigation plan, Methods of acquiring accident facts, Supervisory role in accident investigation, accident theories industrial safety – Man vs. Machine, Facts and fact finding – safety psychology and education.	08
Ergonomics at work place, Ergonomics Task analysis, Preventing Ergonomic Hazards, Work space Envelops, Visual Ergonomics, Ergonomic Standards, and Ergonomic Programs.	08
Hazard cognition and Analysis, Human Error Analysis – Fault Tree Analysis – Emergency Response - Decision for action – purpose and considerations, Engineering versus management control, Hazard control measures – industries and hospitals ,	08
Fire prevention and protection - Fire Triangle, Stages of Fire development, Effect of Enclosures, Need for Early Detection of Fire, Classification of fire and Fire Extinguishers.	08
Electrical Safety, Product safety – Technical Requirements of Product safety. Handling of chemicals- Routes of entry, sources of information used to convey a chemical's hazard, Safehandling of chemicals, safe handling of Equipments and training.	06

Health considerations at work place, types of diseases and their spread, Biomedical Waste (Handling and Management) Rules and its amendments. Potential Hazards and their control in different sectors of Health care facilities like Hospitals, Health Care Units, and Pathology Labs. Health Emergency.	10
Personal Protective Equipment (PPE) – types and advantages. **Occupational Health and Safety** considerations in water and wastewater treatment plants. Handling of chemical and safety measures in water and wastewater treatment plants and labs.	09
Total	**65**

TEXT BOOKS

- Goetsch D.L., (1999), "Occupational Safety and Health for Technologists, Engineers and Managers", Prentice Hall.
- Heinrich H.W., (2007), "Industrial Accident Prevention - A Scientific Approach", McGraw Book Co.

REFERENCES

- Colling D.A., (1990), "Industrial Safety Management and Technology", Prentice Hall, New Delhi.
- Della D.E., and Giustina, (1996), "Safety and Environmental Management", Van Nostrand Reinhold International Thomson Publishing Inc.
- Biomedical Waste (Handling and Management) Rules
- National Safety Council and Associate (Data) Publishers Pvt. Ltd., (1991), "Industrial Safety and Pollution Control Handbook"
- Trevethick, R.A., (1973), "Environmental and Industrial Health Hazards"- William Heinemann Medical Books Ltd., London.

ADVANCED COMPUTATIONAL METHODS AND OPTIMIZATION
(ELECTIVE II)

EVH 152 **Credits – L:T:P = 4:1:0** **CIE: 50 Marks**
Hours/Week: 4(L) + 1(T) **SEE: 100 Marks**

Course Objective
The course introduces both numerical methods and analysis along with optimization and statistics. The student will be gaining knowledge of partial differential equations, their analytical solutions. Optimization deals with both problems with constraints and without constraints. The course lays the base for statistical methods and their applications for environmental data analysis and interpretation.
At the end of the course the students will be able to:

CO1: Analyse the partial differential equations using Newton-Raphson and Finite Element methods and arrive at solutions.
CO2: Apply explicit and implicit methods to solve simple parabolic problems
CO3: Classify, analyse and solve simple to complex optimization problems with and without constraints.
CO4: Apply numerical search method for both linear and non-linear problems. Use interpolation methods for environmental data analysis and interpretation.
CO5: Describe and apply concepts of probability, central tendency and distribution. Methods to characterize or analyse the environmental data**.** Formulate null hypothesis and apply regression analysis for a given set of data.

Content	Hours
Numerical Methods Newton – Raphson method for solution of simultaneous equations, Numerical solutions of partial differential equations, finite difference, finite element method, explicit and implicit methods to solve simple parabolic differential equations.	15
Optimization Classification of optimization problems. Importance in Environmental Studies. Single and multivariable optimization without and with constraints. Linear programming – standard form of problems – pivotal reduction of equations. Single and two-phase simplex methods.	20
Numerical search methods for I – D, non-linear problems -Dichotomous. Fibonacci and Golden section methods. Quadratic and cubic interpolation methods. Solutions of linear programming problems.	10
Statistics and Probability Frequency Distribution – Characteristics of Distributions: Central tendency and dispersion. Concepts of Probability – Binomial, Poisson and Normal distribution – applications, methods of least square and regression, multiple regression, Chi-squared test, F test, t-test. Analysis of Variance – Tolerance and control charts. Solutions of regression analysis problems.	20
Total	**65**

TEXT BOOKS

- Rao, S.S., (1996), **"**Optimization: Theory and applications**"** - Wiley Eastern Ltd. Publications
- Shanthakumar M., (1987), "Computer Based Numerical Analysis", Khanna Publishers
- Levin R I., (2008), "Statistics for Management", Pearson Education India

REFERENCES

- Anthony Ralston, and Philip Rabinowitz,(2001), "A First Course in Numerical Analysis" - Second Edition, Published by Dover Publications
- Desai, C.S., and John F Abel ,(1972), "Introduction to the Finite Element Method: Numerical Method for Engineering Analysis" -Van Nostrand Reinhold, New York
- Taha, H.A., (2008), "Operations Research – An Introduction, 8th edition, Pearson Education India.

AIR & NOISE POLLUTION AND CONTROL
(ELECTIVE II)

EVH 153 **Credits – L:T:P = 4:1:0** **CIE: 50 Marks**
Hours/Week: 4(L) + 1(T) **SEE: 100 Marks**

Course Objective

The course covers the air pollution sources, classification, effects, and measurement of air pollutants, standards, importance of meteorology in air pollutant dispersion, fate and transport of air pollutants using various mathematical tools, as well as air and noise pollution control technologies and regulations.

At the end of the course the students will be able to:

CO1: Understand the importance of composition and structure of atmosphere, sources, classification, effects of air pollutants, and measurement of air pollutants, air pollution standards and control regulations, carryout experiments on different monitoring tests for ambient air quality parameters.
CO2: Understand the basic concepts of various meteorological factors which influence the dispersion of air pollutants and to create wind rose diagram.
CO3: Prediction of dispersion of air pollutants using different models and to evaluate the plume rise using various model equations and get a fair knowledge on stack sampling.
CO4: Understand and analyze the basic mechanisms involved, working principles and design aspects of various air pollution controlling equipment's through demonstration.
CO5: Understand about sources, standards, measurement, effects and general controlling methods of noise pollution and also measurement and interpretation of light intensity for different applications.

Content	Hours
Introduction Structure and composition of the atmosphere, sources and classification of air pollutants, air pollution episodes of environmental importance. Effects on human health, vegetation, animals, materials and monuments. Visibility problems.	07
Meteorology Wind circulation, lapse rates, atmospheric stability conditions, wind velocity profile, Maximum Mixing Depth, Temperature Inversions, plume behavior, Wind rose diagram, general characteristics of stack emissions, heat island effect.	07
Monitoring of particulate matter Respirable, non-respirable and nano - particulate matter. Monitoring of gaseous pollutants – CO, CO_2, Hydrocarbons, SO_X and NO_X, photochemical oxidants. Monitoring equipment – stack sampling (Isokinetic sampling), ambient air sampler (HVAS), microbial air sampler, auto gas exhaust analyzer. Air Pollution Index.	08
Pollutants' dispersion models Gaussian plume dispersion model - dispersion coefficient; point, line and volume sources, Pasquill and Gifford atmospheric stability classification. Prediction Models, Box model, plume rise and effective stack height calculations.	07
Air Pollution Control Equipment	10

Mechanisms, Control equipment for particulate matter – gravity settling chambers, centrifugal collectors, wet collectors, scrubbers, fabric filters, electrostatic precipitator (ESP), Design aspects, general control measures of air pollution.	
Control Equipment for gaseous pollutants – adsorption, absorption, condensation and combustion. Incinerators for Biomedical waste disposal – types and design.	08
Indoor Air Pollution Indoor air quality – hospitals, health care facilities, residential and commercial establishments, effects and control. air changes per hour (ACH), IAQ Standards.	07
Noise Pollution Sources, measurements, effects and occupational hazards. Standards, Noise mapping, Noise attenuation equations, control measures. Impacts of industrial noise on workers, aircraft noise on residential area, effects of highway noise on residential area.	06
Lab Component Monitoring of ambient air quality parameters using H.V.A.S. Measurement of indoor air quality using microbial air sampler Vehicular exhaust analyser for petrol and diesel vehicles. Demonstration / Exercises on Air Pollution Control Devices - Bag Filter, Scrubber, Cyclone and ESP. Measurement of intensity of sound and light	05
Total	**65**

TEXT BOOKS

- Wark, K., Warner, C.F., and Davis, W.T., (1998), "Air Pollution"- Its Origin and Control"- Harper & Row Publishers, New York.
- Perkins, H.C., (1980), "Air Pollution" - McGraw Hill.

REFERENCES

- Crawford, M., (1980), "Air Pollution Control Theory"- TATA McGraw Hill.
- Stern, A.C., Air Pollution, Vol I, II, III.
- Stern, A. C., (1977), "Air Pollution : The Effects of Air Pollution" – 3rd- Edition, Academic Press
- Environmental Engineering - A Design Approach - Sincero, A.P. andSincero, G.A. (1999), Prentice Hall of India, New Delhi.

DESIGN OF WASTEWATER TREATMENT SYSTEMS

EVH210 **Credits–L:T:P=3:2:0** **CIE:50 Marks**
Hours/Week:3(L)+2(T) **SEE:100 Marks**

Course Objective
The course emphasizes on design criteria, design equations, kinetics, and hydraulic diagrams for the design of unit operations and processes for wastewater treatment. It also deals with biological sludge handling and treatment. Discusses the importance of rural sanitation systems and natural and constructed wetlands.

At the end of the course the students will be able to:

CO1: Explain the need for wastewater treatment, categorize the waste water based on characteristics, illustrate reactor types in waste water treatment; explain the basic concept of Mass balance; plan the treatment scheme through flow diagram and hydraulic profile.
CO2: Understand and apply the design principles and criteria in designing units such as screen, grit chamber, primary settling tank. Establish bio-kinetic constants in the engineering design of Waste water treatment processes.
CO3: Describe the design criteria and design the suspended and attached growth biological Wastewater treatment systems like activated sludge process, trickling filter, UASB, RBC
CO4: Explain the need for sludge separation, conditioning and volume reduction. Design the Facilities for treatment of biological sludge
CO5: Illustrate wastewater treatment systems for rural areas. Explain the applicability of Natural systems for treatment of wastewater.

Content	Hours
Domestic Wastewater characteristics, flow fluctuations, types of reactors and mass Balance approach.	05
Wastewater Treatment Flow Diagrams and Hydraulic Profile.	03
Design criteria and design of unit operation systems-screen, grit chamber equalization basin, primary settling tank.	08
Kinetics of biological wastewater treatment systems–biokinetic constants and their determination, batch and continuous system.	09
Design Criteria and design of unit processes systems – suspended and attached growth systems, conventional activated sludge process and its modifications.	10
Design principles of trickling filter, bio-towers and rotating biological contactors.	05
Biological Sludge separation, conditioning and volume reduction	08
Design of Sludge Processing units–secondary settling tank, sludge thickeners and digesters– aerobic and anaerobic.	10
Wastewater treatment systems for small communities–septic tanks, soak pits, two-Pit latrines, eco-toilet. Natural and constructed wetlands,	07
Total	**65**

TEXTBOOKS

- Karia G.L., and Christian R.A., (2001), "Wastewater Treatment Concepts and Design Approach", Prentice Hall of India Pvt. Ltd., NewDelhi.
- Metcalf and Eddy Inc.,(2003),"Waste water Engineering- Treatment and Reuse",4thEdition,Tata McGraw Hill Publishing Co.Ltd.,NewDelhi.

REFERENCES

- Benefield R.D., and Randal C.W., (1980), "Biological Process Design for Wastewater Treatment", Prentice Hall, Englewood Chiffs, NewJersey.
- Ronand L.,and Droste, (1997)," Theory and Practice of Water And Wastewater Treatment" ,John Wiley and SonsInc.
- Gaudy, "Advanced Wastewater Treatment".

EPIDEMIOLOGY AND RISK ASSESSMENT

EVH 220	**Credits – L:T:P = 4:1:0**	**CIE: 50 Marks**
Hours/Week: 4(L) + 1(T)		**SEE: 100 Marks**

Course Objective

The course is interdisciplinary bringing in the concepts of medical epidemiology and its relationship with the associated risks caused due to a variety of diseases and their control aspects. The course also reviews the local, district and national level Health Management system. It covers risk identification, characterization and communication. It deals with partitioning and portioning coefficients' determination for toxic and hazardous pollutants.

At the end of the course the students will be able to:

CO1: Review and describe the history and scope of epidemiology. Discuss spatial and temporal studies in epidemiology, its interventions and experimental studies.
CO2: Classify and differentiate infectious diseases. Identify the epidemiological characteristics of each disease. Define and discuss morbidity and mortality as applied to epidemiological survey.
CO3: Carry out field investigation studies with respect to food and water contamination. Relate population and epidemiological information
CO4: Perform data epidemiological data processing, analysis and interpretation. Plan for a detailed district health management system.
CO5: Identify, characterize and analyse risk and its impacts on human health and environment. Carry out exposure assessment to arrive at lethal concentrations and lethal dosages. Describe portioning and determine portioning coefficients.

Content	Hours
Epidemiology; the historical context; definition and scope of epidemiology; achievements in epidemiology; spatial and temporal studies in epidemiology; Cross Sectional Studies; Case control studies; cohort studies; intervention and experimental studies; Epidemiology: The foundation public health	12
Epidemiology of Infectious Disease: Classification of Infectious Diseases; Epidemiological Characteristics of Infectious Diseases; Surveillance of Infectious Diseases: Temporal Trends of Infectious Diseases; Recent Trends in Infectious Disease; Morbidity and Mortality in the India; Recent Worldwide Trends in Infections Disease Morbidity and mortality. Meta analysis.	12
Field investigations (biological and chemical parameters) related to food and water contamination.	08
District Health Management; District Population; Epidemiological Health Information; Reporting and Surveillance Systems; Data Processing and Analysis; Presenting Health Information; Communicating Health Information; Epidemiology and District Health Planning. Primary Health Centres.	10
GIS and Micro Computer Applications in Epidemiology	06
Risk Assessment: Definition of Risk and its importance. Risk Identification. Risk characterization. Risk communication. Ecological Health impact assessment. Exposure assessment. Health impact assessment, Health impact of various risk factors.	10
Sorption/ partitioning of organics, volatilization and structural / property activity relation.	07
Total	**65**

TEXT BOOKS

- Vaughan. J.P., and Morrow, R.H., (1989) – "Manual of Epidemiology for District Health Management". – WHO, Publication.
- Kenrad.E. Nelson, Carolyn Master Williams, Neil M.H. Graham, (2001), "Infectious Disease Epidemiology - Theory and Practice" - ASPEN Publication, Maryland-
- Lagrega M.D., Buckingham P.L., and Evans J.C., (1994), "Hazardous waste Management", McGraw Hill International Edition

REFERENCES

- Beaglehole, R., Bonita, R., and Kjellstrom, T., (1993), "Basic Epidemiology", WHO publication.
- Barker and Hall, (1991) "Practical Epidemiology" - Churchill Livingstone, Edinburgh.
- Sawyer, C.N., McCarty, P.L., and Park, G.F., (2003), "Chemistry for Environmental Engineering and Science" – V Edition, Tata McGraw HillPublications
- Wentz C. A.,(1995),"Hazardous Waste Management", McGraw Hill International Edition

MUNICIPAL AND BIOMEDICAL WASTE MANAGEMENT

EVH 230 **Credits – L:T:P = 3:2:0** **CIE: 50 Marks**
Hours/Week: 3(L) + 2(T) **SEE: 100 Marks**

Course Objective
The student will have a thorough knowledge of biomedical waste sources, types, and characteristics and also the difference in handling and processing technique compared to any other waste management. The course provides complete theoretical and practical aspects on biomedical waste treatment and best management practices.

At the end of the course the students will be able to:

CO1: Able to categorize the waste based on the Municipal and Biomedical Waste (Management and Handling) Rules and different sources. And also to explain present scenario of waste management and theimpact of its mismanagement.
CO2: Will be in a position to carryout survey on various aspects of biomedical wastes at different point of generation. And also to enumerate various handling and processing techniques on all the categories of wastes.
CO3: Capable of demonstrating specific treatment methods for biomedical wastes and also identifying best equipment for incineration and containments of wastes.
CO4: Proficient enough to train and carryout awareness programmes among the waste handlers at various stages there by helping to safeguard the health.
CO5: Develops the standard procedures for handling and disposal of biomedical wastes generated at various stages. And can also model the waste flow to maintain the standards with assistance of engineering design.

Content	Hours
Introduction Sources of solid waste, engineering classification, characterization, quantification; functional elements of solid waste management system– Environmental implications of open dumping, Construction debris – management & handling.	06
Waste Generation: Rate of generation, frequency, storage and refuse collection, Physical and chemical composition, quantity of waste, engineering properties of waste. **Collection, Segregation and Transport:** Handling and segregation of wastes at source, Collection (primary &secondary) and storage of municipal solid wastes, collection Equipment, transfer stations, collection route optimization and economics, regional concepts. System dynamics,	10
Introduction: Health Care Facilities, Global, National and State; Impact of improper management of waste. **Categories:** BMW (Management and Handling) Rules, Waste categorization and collection, disposal. Types, Generation, Quantification, Segregation and Disinfection of Biomedical waste within the hospital, Methods of Disposal, Training andAwareness.	07
Waste handling within the Facility: suitable receptacles for each waste, ColorCoding, Containers, labeling - international biohazard symbol, corrosive, explosive, radioactive, chemical, cytotoxic.	05
Infectious Waste: Types, Sharps, precaution, handling and proper system of sharp collection and disposal, containers and destroyers. **Non-infectious Waste**: Need for Segregation of Non-infectious Waste from infectious Waste, Precautions for treatment.	05

Liquid Waste: Segregation and Management of liquid waste, Disposal methods, Mercury Spill, Pharmaceutical liquid waste, Photographic liquid waste. Solidification of liquid waste. **Radioactive Waste:** Types, Precautions to be adopted in handling radioactive materials in Hospitals, waste containment methods.	05
Hazardous waste: Definition, Sources /generation of Hazardous wastes, Classification and Characterization of Hazardous wastes. Regulations for Hazardous Waste Management. Cradle to grave concept, Assessment of Hazardous waste sites.	06
Treatment Methods: Refuse processing technologies. Mechanical and thermal volume reduction. Biological and chemical techniques for energy and other resource recovery: Composting methods, Incineration.	07
Disposal Methods: Impacts of open dumping, site investigation and selection, sanitary Land filling-Types, geotechnical considerations, design criteria and design, Liners.	07
Operational aspects of MSW Landfills: Daily cover, leachate disposal, Ground Water monitoring, leachate and gas collection systems–Design, leachate treatment. Landfill post-closure environmental monitoring; land fill remediation.	07
Total	**65**

TEXT BOOKS

- Lowbury EJL, Aylife GAJ, Geddes AM, Williams J D, "Control of hospital infection", (Ed) First edition, 1975, Chapman and Hall Ltd.
- Landrum, V.J.,(1991) "Medical Waste Management and disposal" – Noyes Data Corporation, Newyork
- Stricoff Scott R., and Walters B. Dougals, (1995) "Laboratory Health and Safety" 2nd edition, - John Wiley and Sons Inc.
- Tchobanoglous G.,Theissen H., and EIiassenR., "Solid Waste Engineering Principles and Management Issues", Mc Graw Hill, NewYork.
- Pavoni J.L.,"Hand book of Solid Waste Disposal".
- Peavy, Rowe and Tchobanoglous, "Environmental Engineering",McGrawHill.
- Mantell C.L., (1975), "Solid Waste Management",JohnWiley.

REFERENCES

- CPHEEO Manual on Solid Waste Management.
- WHO Manual on Solid Waste Management.
- Vesiland A., "Solid Waste Engineering", Thompson Books.
- Flintoff F.,(1976),"Management of Solid Wastes in Developing Countries", WHO Regional Publications, South East Asia, NewDelhi
- Basavanthappa, BT (2008), "Community Health Nursing", Second Edition, 2008,Jaypee Brothers Medical Publishers (P) Ltd. New Delhi
- Anantpreet Singh and Sukhjit Kaur (2012), "Biomedical Waste Disposal" First Edition 2012, Jaypee Brothers Medical Publishers (P) Ltd. New Delhi
- Srishti Survey Report on medical waste disposal practice in healthcare unit, 1998 &1999.
- Srishti Fact Sheets on medical waste incineration, mercury, sharps handling and disposal and plastic in healthcare.
- WHO. Laboratory Biosafety Manual 2nd Edition, 1993 World Health Organization,AITBS Publishers and Distributors.
- WHO. Managing Medical Waste in Developing Countries, 1994 world Healthorganization, Geneva

BIOLOGICAL TREATMENT PROCESSES LAB

EVH 270 **Credits – L:T:P = 0:0:1.5** **CIE: 50 Marks**
Hours/Week: 3 Hrs/week

Course Objective
The lab course provides an opportunity to collect and preserve domestic wastewater samples as well as industrial effluents, conduct various tests on wastewater characteristics, perform experiments on selected lab scale treatment processes. It also enriches the student knowledge of determining bio kinetic constants for aerobic treatment process. The lab course alsoexposes the student to carryout analysis on biological sludge developed during the biological treatment of wastewater

At the end of the course the students will be able to:

CO1: Acquaint with the planning of domestic wastewater and industrial wastewater collection, transportation and preservation of samples. Perform standard tests for qualitative analysis and quantification of organic load. Conduct continuous CBOD and NBOD test.
CO2: Design and use the experimental set up to determine bio kinetic constants of biological waste treatment process. Characterize bio sludge through standard procedure to identify significant parameters.
CO3: Plan and perform aerobic and anaerobic bench scale treatment processes on both domestic wastewater and industrial effluent. Use constructed wetland (bench scale) system as polishing unit. Develop the skill of analysing, interpreting and inferring the laboratory data.

Experiment	Hours
Domestic and Industrial Wastewater analysis for different parameters	06
Determination of CBOD and NBOD of both domestic and industrial wastewater using BOD apparatus	06
Determination of Bio kinetic Constants - F/M, Θ, Θ_c ,K_d, Y, q, μ,	06
Analysis of Biological Sludge – MLSS, MLVSS, SVI	06
Aerobic process of treating domestic wastewater	06
Anaerobic process of treating domestic wastewater	06
Polishing unit – constructed wetland	06
Total	**42**

REFERENCES

- American Public Health Association, American Water Works Association, (1998), Standard Methods for Examination of Water and Wastewater, 20th edition, APHA.
- Adams and Eckenfelder Jr. W.W. (1974), "Environmental, Process Design Techniques for Industrial Waste Treatment", Nashville (USA), 1974.
- Benefield, L.D., and Randall, C.W., (1980), "Biological Process Design for Wastewater Treatment", Prentice Hall, Englewood, Chiffs, N.J.
- CPHEEO Manual (2014), "Wastewater Collection, Treatment and Disposal", Ministry of Urban Development, Government of India, New Delhi.
- Metcalf and Eddy, (2003), "Wastewater Engineering, Treatment and Reuse", 4th Edition, Tata McGraw Hill Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

MEDICAL STATISTICS AND HEALTH CARE ADMINISTRATION
(ELECTIVE III)

EVH 241 **Credits – L:T:P = 3:2:0** **CIE: 50 Marks**
Hours/Week: 3(L) + 2(T) **SEE: 100 Marks**

Course Objective

The course encompasses both medical statistics and health care administration. It discusses basic statistical data analysis methods. Introduces parametric and non-parametric tests on the medical data. Describes correlation and regression analysis. It also deals with survival analysis, sensitivity and specificity of medical data. It lays foundation on health care investments, health care administration. It explains the pros and cons of telemedicine and health care tourism. It provides knowledge on managing health care services during emergencies and disasters.

At the end of the course the students will be able to:

CO1: Apply descriptive statistics for any set of data including medical data. Understand the confidence intervals and p values.
CO2: Perform parametric and non-parametric tests on the data. Differentiate between risk ratio and odds ratio.
CO3: Carry out correlation and regression analysis and explain Cox regression model. Describe sensitivity, specificity and predictive values.
CO4: Justify health care administration need and health care investments. Explain the the associated problems with health care investments. Manage quality in health care facilities.
CO5: Review pros and cons of telemedicine and medical tourism. Discuss the role of health care insurance and reimbursement. Apply the knowledge to manage health services at the time of emergencies and disasters. Discuss the legal frame work for health care administration.

Content	Hours
Statistics Descriptive Statistics –Mean, Median, Mode, Standard Deviation, percentages	07
Statistics of Confidence testing – confidence intervals, p values	07
Statistics of differences- t tests and parametric tests, chi-squared, Mann-whitney and other non-parametric tests, risk ratio, odds ratio	10
Correlation and regression, Survival analysis, life tables, Koplan Meier Plots, Cox Regression model	08
Sensitivity, specificity and predictive value	04
Level of agreement and Kappa	04
Health Care Administration Health care, effective media communication, health care financing, quality in health care	10
Telemedicine and Medical tourism	04
Role of health insurance	04
Managing Health services during emergencies and disasters	03
Medico legal aspects.	03
Total	**65**

TEXT BOOKS

- Sundar Ram K.R., (2014), "Medical Statistics – Principles and Practice", 2nd Edition, Wolter Kluwer Publishing
- Goyal R.C., and Sharma D.K., (2013), Hospital Administration and Human Resource Management", PHI Publishing

REFERENCES

- Michael Harris and Taylor G, (2003), "Medical Statistics Made Easy", Martin During, London and New York
- Joshi D.C., and Mamta Joshi, (2009), "Hospital Administration", 1st Edition, Jaypee Brothers Medical Publishers.

OPERATION AND MAINTENANCE OF ENVIRONMENTAL FACILITIES (ELECTIVE III)

EVH 242 **Credits – L:T:P = 3:2:0** **CIE: 50 Marks**
Hours/Week: 3(L) + 2(T) **SEE: 100 Marks**

Course Objective

The course encompasses the aspects of operation and maintenance of Environmental facilities. It highlights the operational problems and suggests the control, preventive and corrective measures.

At the end of the course the students will be able to:

CO1: Know the need, types, basic principles, organizational structure, work planning and scheduling and cost estimates of O&M
CO2: Explain the importance of drawings, plans, record keeping. Recognize the need for operational manual and SOP. Discuss the advantages and limitations of SCADA based control systems
CO3 Identify and list the operational problems in water treatment and supply facilities. Apply preventive and corrective maintenance measures
CO4: Describe the operational problems in wastewater collection and treatment facilities. Enumerate the remedial measures. Explain the problems and control measures in Industrial wastewater treatment facilities
CO5: Identify and discuss the troubles in air pollution control systems and suggest the preventive and control measures

Content	Hours
Importance of Operation & Maintenance, Basic Principles, Objectives, Requirements, Proactive, reactive and predictive maintenance systems. Corrective and Preventive Maintenance, Units and measurements.	08
Operation & Maintenance Planning - Organizational Structure, Work Planning, Preparation and Scheduling, Cost Estimates.	12
Data Base of Facilities for O&M – Detailed Plans, Drawings, Operation Manuals, Record keeping, standard operating procedure and Computer Applications in O&M and SCADA.	12
O&M of Water Treatment and Supply and Facilities, Operational Problems and Corrective Measures in Different Units of Treatment. Water Distribution Network. O & M of water resources. O & M of disinfection systems Operational problems and trouble shooting and solutions in water and wastewater treatment systems.	12
O&M of Wastewater Collection and Treatment Facilities, Operational Problems and Corrective Measures in Different Units of Treatment, sewer network system. O & M of Industrial wastewater systems. O & M of Leaking Underground storage tank. O & M of Industrial areas/land uses	12
O&M of Air Pollution Control Facilities, Operational Problems and Corrective, Measures in Different Units of Treatment. O & M of Air and noise pollution control systems, O & M of all Air pollution control equipment	09
Total	**65**

TEXT BOOKS

- Hammer M.J., and Hammer Jr. M.J., (2008), "Water and Wastewater Technology", Prentice Hall of India Pvt. Ltd., New Delhi.
- Metcalf and Eddy Inc., (2003), "Wastewater Engineering - Treatment and Reuse", 4th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

REFERENCES

- Training Manual on O&M for Municipal Staff, Asian Development Bank Project, Government of Karnataka
- CPHEEO Manual, (1991) "Water Supply & Treatment", GOI Publication.
- CPHEEO Manual., (1995) on Sewerage & Sewerage Treatment, GOI Publication.
- National Safety Council and Associate (Data) Publishers Pvt. Ltd., (1991), "Industrial Safety and Pollution Control Handbook"

DESIGN OF ADVANCED WASTEWATER TREATMENT PROCESSES (ELECTIVE III)

EVH 243 **Credits – L:T:P = 3:2:0** **CIE: 50 Marks**
Hours/Week: 3(L) + 2(T) **SEE: 100 Marks**

Course Objective

The course covers in depth the advanced and hybrid wastewater treatment systems for the removal of nutrients, toxic organics, inorganic and trace contaminants, as well as sludge handling and disposal practices. It allows the student to understand design criteria and design the various advanced wastewater treatment processes.

At the end of the course the students will be able to:

CO1: Acquire knowledge of residual pollutants in the effluent of conventionally treated wastewater and their removal by various advanced processes.
CO2: Describe different combinations of hybrid reactor systems and to design them for a given situation
CO3: Apply the knowledge of nutrients removal using advanced wastewater treatment processes design
CO4: Familiarize with the handling and disposal methods of both biological and chemical sludge from wastewater treatment facilities and comprehend the knowledge on recent advanced technologies. Apply design principles in designing the facilities
CO5: Discuss the need for application of environmental biotechnology for wastewater treatment. Differentiate in-situ and ex-situ bioremediation processes. Design Membrane bioreactors using design principles. Review the option of using wastewater for other purposes.

Content	Hours
Advanced Wastewater Treatment Systems Residuals in treated wastewater and their removal Gas Stripping, DAF, Advanced Oxidation, and Electro dialysis, Ion Exchange & Adsorption, Micro and Ultra Filtration	12
Hybrid Wastewater Treatment Systems Need for upgrading treatment plants, Possible Combinations of Physico chemical and Biological Processes. Electrochemical coagulation, UASB and Anaerobic filters, multistage anaerobic filters	13
Nutrients' Removal from Wastewaters Nitrification and denitrification, physicochemical and biological phosphorus removal, SBR.	08
Sludge Chemical Sludge – Sources and generation, types, characterization, recovery of metals, and alternate uses Biological sludge – Sources and generation, characterization, utilization possibilities compost	16
Recent Trends Environmental Biotechnology - genetically engineered microorganisms for wastewater treatment, bio remediation, bio sensors, membrane bio reactors (MBR), power generation from wastewater.	16
Total	**65**

TEXT BOOKS

- Metcalf & Eddy Inc, (2003), "Wastewater Engineering, Treatment and reuse"- 4th Edition, Tata McGraw Hill Publishers Co. Ltd, New Delhi
- Karia, G.L., and Christian, R.A., (2006) "Wastewater Treatment: Concepts And Design Approach "– Prentice – Hall of India

REFERENCES

- Syed R. Qasim, (1999), "Wastewater treatment plants: planning, design, and operation" - 2nd edition, CRC Press LLC
- Moo-Young M., Anderson W.A., Chakrabarty A.M., (2007), "Environmental Biotechnology – Principles and Applications," Kluwer Academic Publishers.

WATER RECOVERY, REUSE AND RECYCLE TECHNOLOGY
(ELECTIVE IV)

EVH 251 **Credits – L:T:P = 4:1:0** **CIE: 50 Marks**
Hours/Week: 4(L) + 1(T) **SEE: 100 Marks**

Course Objective
The course emphasizes on reuse applications of reclaimed water for agricultural, landscape, industrial, potable and non-potable domestic purposes, potential issues and their management options.
At the end of the course the students will be able to:

CO1: Recognize and explain the need and rationale for water reclamation and reuse, analyse the health and environmental concerns related to reclaimed water reuse, relate water borne diseases with the possible reclaimed water reuse application
CO2: Explain available tertiary treatment technologies for reuse applications identify the potential contaminants and suggest state-of-the-art techniques for their qualitative and quantitative measurement assess market opportunities and conduct economic analysis
CO3: Compute the impacts of reclaimed water on agricultural and landscape applications and work out its feasibility. Recognize the need for reuse policy and discuss reclaimed water quality issues.
CO4: Identify the sectors that serve as beneficiaries for reclaimed water; evaluate the water quality issues and suggest the management options for industrial applications of reclaimed water
CO5: Identify the most appropriate technology for using the reclaimed water for artificial ground water recharge. Examine the direct and indirect use of reclaimed water for potable purposes.

Content	Hours
Introduction: Need and prospects, water reclamation and reuse.	03
Water Reuse Innovation and Public Policy: Water management and system and reclamation innovation, water reuse and public policy. Quality Issues and its management.	07
Water – Reuse Systems: Health and environmental concerns in water reuse – water borne diseases; Factors influencing pathogen inactivation; Endocrine disruptors and pharmaceutically active chemicals.	10
Wastewater Reclaim Technologies: Treatment process reliability, advanced wastewater reclamation processes and their combination, Water Harvesting.	08
Public acceptance of water reuse, implementation hurdles, advanced facilities for analysis of reclaimed water quality, market assessment, economic and financial analysis.	08
Reuse Applications **Agriculture and Landscape irrigation** Agronomic and water quality considerations, salinity, sodality, specific ion toxicity, leaching and irrigation requirement, hydraulic loading rate, drainage system, estimation of water needs	10
Industrial Water Reuse: Water quality issues and their management options – corrosion, scaling, biological fouling; Cooling tower, makeup and blow down water;	08

boiler system using reclaimed water; Water pinch analysis.	
Ground Water Recharge with Reclaimed Water: Rationale, Ground water recharge methods, water recharge guidelines	08
Potable Reuse – Indirect and direct.	03
Total	**65**

TEXT BOOKS

- Metcalf & Eddy Inc, (2003),"Wastewater Engineering, Treatment and reuse"- 4th Edition, Tata McGraw Hill Publishers Co. Ltd, New Delhi
- Takashi Asano, Franklin L. Burton, Harold L. Levering, Ryujiro Tsuchihashi, George Tchobanoglous, (2007) "Water Reuse – Issues, Technologies, and Application", McGraw Hill Company, Copyright by Metcalf & Eddy, Inc.

GIS FOR HEALTH CARE MANAGEMENT
(ELECTIVE IV)

EVH 252 **Credits – L:T:P = 4:1:0** **CIE: 50 Marks**
Hours/Week: 4(L) + 1(T) **SEE: 100 Marks**

Course Objective
The course lays the foundation for concepts of Geographical Information System, coordinates and projection, data models, spatial data input and editing, database management, as well as the applications of GIS in health care business, emergency response, tele-health. It also introduces the basics of Remote Sensing including sensors, platforms and orbits and satellite images.

At the end of the course the students will be able to:

CO1: Recognize the importance and need of GIS in environmental management; explain the concepts of co-ordinates and projection system and examine their relevance. Review Remote Sensing basics.
CO2: Differentiate between raster and vector data models and suggest suitability of these data types to represent various geographic features, determine data input method, identify the errors and suggest methods of editing the data to remove the errors.
CO3: Perform raster and vector overlay analysis, spatial interpolation, explain network analysis.
CO4: Explain database structure models, formulate database management system to represent healthcare related data; Discuss web GIS.
CO5: Formulate programs to carry out projects for visualizing and analysing health-related data. Apply GIS to various health care management in epidemiology, healthcare business, tele-health service delivery, emergency response, correlation/pattern analysis, etc.

Content	Hours
Introduction Origin and importance of GIS; scale; coordinate and projection systems	05
Basics of remote sensing: EMR spectrum; Energy sources and radiation laws, Energy interactions with atmosphere and Earth's surface features; Spectralreflectance curves, airborne and space borne sensors, passive and active remote sensing, Platforms and orbits; Satellite system parameters, spectral, radiometric, spatial, and temporal resolutions of satellites	12
Data Models and Structures Spatial data models – Raster, vector; spatial and attribute data.	08
Spatial Data Input and Editing Data input: keyboard, digitization electronic data transfer, GPS; Data Editing: spatial and attribute data errors and accuracy, concept of topology, data generalization	10
Spatial Analysis Raster and Vector overlay analysis; Buffering and Neighborhood function, Networks; Spatial interpolation;	09
Spatial Database Management System Data storage, database models, database management system	06

Introduction to Web GIS **Applications of GIS in healthcare administration, management and policy** Mapping, Measuring, Monitoring and Modeling - GIS applications in epidemiology, health risk mapping, network analysis, GIS for healthcare business, emergency responseservice coordination, rural health-service analysis, tele-health service delivery coordination, patient care and room management, marketing strategies. IoT (Internet of Things) concepts	15
Total	**65**

TEXT BOOKS

- Burrough, P. A., McDonnell, R. A., Lloyd, C. D. (2015), "Principles of Geographical Information Systems", 3rdEdition, Oxford University Press,
- Michael N. DeMers (2008) "Fundamentals of Geographical Information Systems", 4th Edition, John Wiley and Sons. Inc

REFERENCES

- Anji Reddy (2008) "Text Book of Remote sensing and Geographical Information systems", 3rd Edition, B. S. Publications, Hyderabad
- Longley, P. A., Goodchild, M. F., Maguire, D. J., and Rhind, D. W., (2005) Geographical Information Systems: Principles, Techniques, Management and Applications, 2nd Edition, John Wiley & Sons, 2005.
- Elmasri, Ramez; NavatheShamkant. B. Fundamentals of Database Systems, (2007), 5th Edition, Pearson Education, Inc.,
- GIS in Hospital and Healthcare Emergency Management, (2010), Edited by Ric Skinner, GISP, CRC Press, Taylor & Francis Group,
- Romley, Ellen K., McLafferty Sara L. (2012), "GIS and Public Health", The Guilford Press
- Journal articles in reputed journals describing applications of GIS in Healthcare management

HEALTH CARE POLICY AND LEGISLATION
(ELECTIVE IV)

EVH 253 **Credits – L:T:P = 4:1:0** **CIE: 50 Marks**
Hours/Week: 4(L) + 1(T) **SEE: 100 Marks**

Course Objective

The course deals in detail the need for health care policy and public health. It provides details on the role and responsibilities of organizations involved in health care. It reviews Indian Rules and Regulations, discusses various health related acts and rules. The course also highlights the health insurance products and policies along with legal issues for healthinsurance claims.

At the end of the course the students will be able to:

CO1: Discuss the need and basic aspects of public health. Describe the essentials of health care policies, roles and responsibilities of organizations involved.
CO2: Explain the importance of Indian Acts related to health. Identify different laws and describe the salient features of pharmacy act, drug act, biomedical rules and human organs transplantation act
CO3: Review the salient features of Maternity benefit act, Medical Termination of Pregnancy act
CO4: Explain and understand the salient features of PNDT and Mental Health acts
CO5: Review the health care policy of India, Identify and discuss different health care products and policies. Identify the legal issues related to health care policy claims

Content	Hours
Health Policy – need and essentials, importance of public health, organizations and agencies in Health Care Policy	15
Indian Laws and Regulations related to Health Pharmacy Act 1948, Drug and Cosmetic Act 1940, the transplantation of human organs Act and Rules, Biomedical Waste (Management and Handling) Rules Maternity Benefit Act and Rules, Acts in Disability The Medical Termination of Pregnancy Act and Rules The Prenatal Diagnostic Techniques (PNDT) Act and Rules Mental Health Act (1987), Food Act	25
Indian Health Care Policy – Medical / Health Insurance Policy Review of Health care in India, Basics of Health Insurance, IRDA Health Regulations 2013, Health Insurance Products and Policies Legal Issues – Health Insurance claims	25
Total	**65**

TEXT BOOKS

- Gangolli L.V., Ravi Duggal and Abhya Shukla, "Review of Health Care in India", Centre for Enquiry into Health and Allied Themes, Mumbai
- Gupta L.P., (2014), "Health Insurance for Rich and Poor in India", (2014), 1st Edition

REFERENCES

- Tietelbaum J.B., Wilkensky S.E.,(2012), "Essentials of Health Policy and Law", 2nd Edition, Jones and Barlett Learning
- Gosfield A.G., (2015),"Health Law Handbook" Health Law Series, Clark Boardman Callaghan.

Technical Seminar on Current Issues

EVH 160/260 **CIE: 50 Marks**

Course Objective: The technical seminar course provides an opportunity to search, understand and select an appropriate contemporary environmental issue, comprehend, infer, identify information gap and arrive at futuristic implications, prepare an abridged report and make multimedia presentation.

At the end of the course the students will be able to:

CO1: Identify and critically review the peer reviewed published documents on current environmental issues.
CO2: Develop creative thinking in identification of research gaps and to provide futuristic perspectives.
CO3: Develop written and multi-media presentation skills based on the literature reviewed.

- This technical seminar is applicable to both first and second semesters of the PG program.
- Students are assessed individually for their abilities on technical understanding, collection of relevant technical material, drawing inferences from published documents, oral and written presentation skills, etc.
- Each student is expected to give a technical seminar on topics related to current environmental issues with focus on research and field.
- Each student shall be under the supervision of a faculty member in the department who oversees the progress related to the technical seminar.
- Each student shall identify and collect relevant recent publications from peer reviewed, scopus indexed and web of science journals, technical reports and manuals. The students are expected to consult the respective guide and DPGC on finalizing the topic. They also are expected to appraise their guide on the progress made in report preparation and final presentation.
- Each student presents his/her chosen topic using multi-media presentation platform on the scheduled date and time, as decided by the Department Post-Graduate Committee (DPGC). The DPGC shall consist of three faculty members identified by HOD along with the HOD as Chairman.
- Each student shall submit the seminar report, approved by the guide, conforming to the standards and format decided by the department/DPGC.
- The course evaluation is based on the quality of technical material, technical understanding, comprehension, analytics, oral and written communication, time management and interactions.

Practical Training in Industry / Exploration Research

EVH 310T **Credits – L:T:P = 0:0:4** **CIE: 100 Marks**

Course Objective: The practical training course provides technical exposure for the students in the field of Environmental Engineering aspects and general administration as practiced in the industrial (goods and services) sector and other technical/scientific and research organizations. The training allows the students to understand, analyze, evaluate, comprehend, and critically think on the concepts learnt during their course curriculum, experience it practically and then write a technical report thus bridging the gap between classroom learning and practical implementation.

At the end of the course, the students will be able to:

CO1: Comprehend the organization structure and general administration, production/working process and environmental management in industries and organizations.
CO2: Critically observe and inculcate individual responsibility as well as team efforts to develop practical solutions towards sustainable development with innovative research and creative thinking.
CO3: Develop written and multi-media presentation skills for effective communication.

- Each student shall undergo industrial training for a duration of 8 weeks in the product/service sector industry or organization/company with an intention to gain exposure to technical reality beyond syllabus.
- The general areas of focus include Environmental Impact Assessment and Audit, Environmental Management Systems, Waste Management, Design-drawing-cost estimation of various environmental components, Operation and maintenance of environmental facilities, Performance evaluation of treatment systems for air and water attributes, Exposure to state-of-art instrumentation, automation and software, Environmental Health and Safety, etc.
- The dates for training are as per the calendar of events announced by the university after the completion of the semester send examination of the 2nd semester.
- Each student and/or by directions given by the faculty members will identify an industry/organization/company for training based on his/her merit and preference.
- During the training period, the student will learn work ethics, communication/managerial skills and application skills and collect useful information required for preparing the report and presentation.
- The industry authorities will be required to provide a comprehensive evaluation of the candidate in the specified format to the department.
- The student will report to the department at the end of the training period.
- The student will be required to prepare and submit a comprehensive report, to Department Post-Graduate Committee (DPGC) with due approval from the guide, on the work done and observation made during the industrial training. The DPGC shall consist of three faculty members identified by HOD along with the HOD as Chairman.
- The student is also required to make an interim presentation (after 4-5 weeks of training) and a final presentation using multi-media presentation platform on the scheduled date and time, as decided by the DPGC.
- The DPGC as well as the respective guide will jointly evaluate the performance of the student.
- The outcome of the internship will be in the form of generating ideas on water savings, energy savings, housekeeping practices and also bringing-in industry related problems to solve in the laboratory and giving feedback to the industries for improvements, following the ethical code of protecting the environmental attributes.

Dissertation work (Phase-I)

EVH 320P **Credits – L:T:P = 0:0:10** **CIE: 100 Marks**

Course Objective: The dissertation work trains the students to carry out literature review, identify the gaps/problems, devise workable objectives and methodology, conduct the investigation following engineering ethics, and analyze, interpret and present the findings and thus develop creative thinking, planning, time management, leadership qualities and managerial skills.

At the end of the course, the students will be able to:

CO1: Conduct systematic review of literature, identify research gaps, and define objectives and scope of work
CO2: Develop skills in terms of design, conduct investigations and data analytics
CO3: Develop oral and written communication skills for report preparation, paper publication and technical presentation

- Each student shall be associated with a faculty member serving as his/her guide to supervise the dissertation work.
- Periodic progress review presentations of the dissertation work shall be according to the calendar of events scheduled by the University.
- The student will work with the project guide/supervisor towards the identification of the problem through a systematic literature review and will finalize the objectives and scope of work.
- The student will present synopsis (review-1) and submit the same to the Department Post-Graduate Committee (DPGC) after due approval from the guide.
- The student will present the work progress as part of review-2 during the 1st phase of the project work.
- The DPGC and guide will jointly evaluate the student.

Dissertation work (Phase-I)

EVH 410P **Credits – L:T:P = 0:0:18** **CIE: 100 Marks**
SEE : 200 Marks

Course Objective: The dissertation work trains the students to carry out literature review, identify the gaps/problems, devise workable objectives and methodology, conduct the investigation following engineering ethics, and analyze, interpret and present the findings and thus develop creative thinking, planning, time management, leadership qualities and managerial skills.

At the end of the course, the students will be able to:

CO1: Conduct systematic review of literature, identify research gaps, and define objectives and scope of work
CO2: Develop skills in terms of design, conduct investigations and data analytics
CO3: Develop oral and written communication skills for report preparation, paper publication and technical presentation

- The student will continue with the 2nd phase of the intended project work as per the directives of the project supervisor.
- Periodic progress review presentations (review-3, review-4) of the dissertation work shall be according to the calendar of events scheduled by the University.
- The student will continue the work towards achieving the objectives of the intended dissertation work taking into consideration the suggestions given by the DPGC with the advice of the project supervisor.
- The student will make final presentation/ demonstration (review-5) of the dissertation work as per the calendar of events to the project evaluation committee.
- The student will prepare a comprehensive report of the dissertation work carried out conforming to the standards and format prescribed by the University and submit the same to the department after due approval from the guide.
- Prepare papers for presentation in seminars / conferences /symposium/workshops and technical paper publications in peer reviewed journals.
- The student will be required to present the dissertation work to a panel of examiners consisting of an external examiner from academia/industry of desirable cadre, supervisor and a member of DPGC on the date scheduled by the University.
- The evaluation of the dissertation work will be done at several levels by the DPGC members, supervisor as well as the external examiner as per the norms of the University.