3rd Semester

Syllabus

DEPARTMENT OF MATHEMATICS						
Course Code: 24MA311		***Engineering Mathematics-III (Common to CV, MECH, IP, ENV, CTM, BT and PST)***				
Total Credits: 03 L-45: T-0: P-0: SL and TW-45		***SDGs addressed: 4, 5, 9, 16, 17***		***Course Category: Basic Science Course***	***Course Type: Theory***	
Teaching Learning Process		***Total Contact Hours/semester***	***Assessment Weightage and Marks***			
	Lecture	***45***		***CIE***	***SEE***	***Total***
	Tutorial	***-***	***Weightage %***	***40***	***60***	***100***
	Practical	***-***	***Maximum Marks***	***40***	***60***	***100***
	Self-learning and Term work	***45***	***Minimum Marks***	***20***	***25***	***45****
	Total	***90***				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Pre-Requisite: Engineering Mathematics I and II

Course objective: This course will enable students to:

1. To introduce the concept of analytic function, transformation for mapping.
2. To introduce the concept of complex variables to evaluate the integrals
3. To introduce the concept of partial differential equations, use separation of variable method to solve wave and heat equations.
4. To make the student to solve system of linear equations, carryout matrix operations, determine the eigenvalues & eigenvectors.
5. To find optimal solutions to engineering problems whose optimum may be a certain quantity, shape and function.

Course Outcomes (CO's): After the completion of this course, students will be able to:

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Apply basic mathematical operations on complex numbers in Cartesian and polar forms. Determine continuity/differentiability /analyticity of a function and find the derivative of a function.	L2	WK1, WK3
CO2	Evaluate a contour integral using Cauchy's integral formula. Compute singularities and also the residues.	L3	WK2, WK6
CO3	Formulate and solve partial differential equations. Use of separation of variable method to solve wave, heat and Laplace equations.	L3	WK1, WK4
CO4	Test the system of linear equations for consistency, Linear Independence and Dependence. Determine and describe the characteristic equation, Eigen vectors and Diagonalization.	L3	WK4, WK8
CO5	Compute extreme values of a variational problems like geodesics, least time and shortest path.	L3	WK2, WK8

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Complex Variables**: Functions of complex variable, Definition of Limit, Continuity, Differentiability. Analytic functions, Cauchy's-Reimann equation in Cartesian and polar forms (Statement only), Properties of analytic functions (Statement only), Construction of Analytic functions, Harmonic Conjugates. **Self-Learning and Term work** • Recapitulation of Basic Concepts • Discuss some application aspects based on properties of analytic functions-Stream lines and Complex potential	**09**
2	**Complex Integration:** Complex integration, Cauchy's theorem (statement only), Converse of Cauchy's theorem, Cauchy's integral formula (statement only), zeros & singularities of an analytic function, residues, residues theorem, calculation of residues. **Self-Learning and Term work** • Evaluation of the line integral over the region C: straight line • Proof of Cauchy's integral formula • Calculation of residues of order four	**09**
3	**Partial differential equations (P.D.E.):** Formation of Partial Differential Equation, Solution of Langrange's Linear P.D.E. of the type Pp+Qq=R. Method of Separation of Variables. Applications of P.D.E.: Classification of PDE, solution of one dimensional heat and wave by the method of separation of variables. **Self-Learning and Term work** • Form Partial differential equation by eliminating arbitrary constants • Derive one dimensional wave equation • Innovative applications of heat equation	**09**
4	**Linear Algebra:** System of linear equations, Row operations, Echelon form Reduced Echelon form, Solution of Homogeneous and Nonhomogeneous equations, vector equations, Linear combinations, Linear independent/dependent vectors, Eigen values, Eigen vectors, Diagonalizations. **Self-Learning and Term work** • Column operation • To fine rank of a matrix by reducing to the normal form • Basic definitions of Homogeneous and Nonhomogeneous equation	**09**
5	**Calculus of Variation**: Variation of a function and a functional, Extremal of a functional, Variational problems, Euler's equation, Standard Variational problems including geodesics, Minimal surface of revolution and hanging chain.	**09**

	Self-Learning and Term work • Discuss Maxima and minima for a function of two variables • Surfaces of least area enclosed by a given boundary	

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

Sl. No	Author/s	Title	Publisher Details
1	B.S. Grewal	Higher Engineering Mathematics	44th Edition, 2015, Khanna Publishers, ISBN: 978- 81-933284-9-1.
2	E. Kreyszig	Advanced Engineering Mathematics	10th Edition (Reprint), 2016, John Wiley & Sons, ISBN: 978-0470458365
3	M.K. Jain, S.R.K. Iyenger and R.K. Jain	Numerical methods for scientific and engineering computation	6th Edition, 2012, New Age International Publishers, ISBN: 9788122433234, 8122433235

Reference Books:

Sl. No.	Author/s	Title	Publisher Details
1	N. P. Bali and Manish Goyal	A Textbook of Engineering Mathematics	Vol. I & II (AICTE), 10th Edition, Laxmi Publications Pvt Ltd, 2019, ISBN: 9789352743766, 9789352743766.
2	Maurice D. Weir, Joel R. Hass and George B. Thomas,	Thomas' calculus: Early Transcendentals	12th edition, Pearson Education, 2016. ISBN: 978-07802-426-9.
3	B. V. Ramana	Higher Engineering Mathematics	11th edition, Tata-McGraw Hill, 2010, ISBN:0-07-053516-7.
4	Peter V.O 'Neil	Advanced Engineering Mathematics	7th edition, CENGAGE Learning India Pvt. Ltd. Publishers, 2012, ISBN: 978- 81-315-0310-2.

Web/Digital resources:

Sl. No.	Web Link
1	https://www.classcentral.com/subject/maths
2	https://academicearth.org/

Course Articulation:

POs → COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-
CO3	3	1	-	-	-	-	-	-	-	-	-
CO4	3	1	-	-	-	-	-	-	-	-	-
CO5	3	1	-	-	-	-	-	-	-	-	-

High – 3, Medium – 2, Low – 1

PO1: ability to apply knowledge of Mathematics
PO2: ability to analyze engineering problems

DEPARTMENT OF MATHEMATICS							
Course Code	***24MATDIP310***	***Total Credits***	***00***	***Course Type***	*Theory-Basic Science Course*		
Course Title	***Foundations of Engineering Mathematics-I (For III Semester Lateral Entry Students) (Non-Credit Course)***						
Teaching Learning Process		***Contact Hours***	***Credits***	***Assessment in Weightage and marks***			
	Lecture	***03***	***00***		***CIE***	***SEE***	***Total***
	Tutorial	***00***	***00***	***Weightage***	***--***	***100%***	***100%***
	Practical	***--***	***--***	***Maximum Marks***	***--***	*60*	***60 Marks***
	Total	***03***	***00***	***Minimum Marks***	***--***	*24*	***24 Marks***

Pre requisites: Basics in Differential calculus, Integral calculus and Vectors.

Course objectives: This course will enable students to:
1. Known the behavior of the polar curve and its application.
2. Learn the notation of partial differentiation and determine the value of the Jacobians.
3. Learn how a function of single variable can be expanded as a Taylor's series and Maclaurin series and Handle the indeterminate form.
4. Learn how the vectors govern the physical models.
5. Known how the real word problems governed by the first order differential equations.

Course Outcome: After the completion of this course, students will be able to:

CO#	**Course Outcome**	**Highest Level of Cognitive Domain**
CO1	Apply the knowledge of calculus to solve problems related to polar curves and its applications in determining the amount of bending of the curve.	L2
CO2	Learn the notation of partial differentiation to calculate rates of change of multivariate functions and solve problems related to composite functions.	L2
CO3	Understand how a function of single variable can be expanded as a Taylor's series and handle the indeterminate form.	L2
CO4	Illustrate the applications of multivariate calculus to understand the characteristics of vector field.	L2
CO5	Apply the analytical methods to solve first order and first degree differential equations and solve some Engineering problems.	L2

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

Course Syllabus:

UNIT No.	Content	Lecture Hours
UNIT 1	**Differential Calculus-I:** Polar curves: angle between the radius vector and tangent, angle of intersection of polar curves. Pedal equation for polar curves. Curvature and radius of curvature in pedal form. (Without proof)	8
UNIT 2	**Differential Calculus–II:** Partial differentiation: Partial derivatives, Total derivatives, differentiation of composite functions. Jacobians.	8
UNIT 3	**Differential Calculus–III:** Taylor's and Maclaurin's series expansions for one variable **(statement only).** Indeterminate forms, L' Hospital Rule (without proof) (Only $\frac{0}{0}, \frac{\infty}{\infty}, 0 \times \infty$ and $\infty - \infty$ form)	8
UNIT 4	**Vector Calculus:** Vector Differentiation: scalar and vector fields, Gradient, directional derivative, divergence, curl-physical interpretation; solenoidal and irrotational vector fields-illustrative problems.	7
UNIT 5	**Differential Equations-I:** Solution of first order and first degree differential equations: Variable Separable, Linear differential equations and Exact differential equations.	8

Text Books:

Sl. No	Author/s	Title	Publisher Details
1	B.S. Grewal	Higher Engineering Mathematics	44th Edition, 2015, Khanna Publishers, ISBN: 978- 81-933284-9-1.
2	E. Kreyszig	Advanced Engineering Mathematics	10th Edition (Reprint), 2016, John Wiley & Sons, ISBN: 978-0470458365
3	M.K. Jain, S.R.K. Iyenger and R.K. Jain	Numerical methods for scientific and engineering computation	6th Edition, 2012, New Age International Publishers, ISBN: 9788122433234, 8122433235

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2	Maurice D. Weir, Joel R. Hass and George B. Thomas,	Thomas' calculus: Early Transcendentals	12th edition, Pearson Education, 2016. ISBN: 978-07802-426-9.
3	B. V. Ramana	Higher Engineering Mathematics	11th edition, Tata-McGraw Hill, 2010, ISBN:0-07-053516-7.
4	Peter V.O 'Neil	Advanced Engineering Mathematics	7th edition, CENGAGE Learning India Pvt. Ltd. Publishers, 2012, ISBN: 978- 81-315-0310-2.

Web/Digital resources:

Sl.No.	Web Link
1	https://www.classcentral.com/subject/maths
2	https://academicearth.org/

Course Articulation Matrix:

POs → / COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-

High – 3, Medium – 2, Low – 1

PO1: ability to apply knowledge of Mathematics

<table>
<tr><td colspan="7">Department: Environmental Engineering</td></tr>
<tr><td colspan="3">Course Code: 24EV310</td><td colspan="4">Course Title: Environmental Chemistry</td></tr>
<tr><td colspan="3">Total Credits: 4
L-45; T-0; P-30; SL&TW: 45</td><td>SDGs addressed:
6, 14, 15</td><td>Course Category:
PCC</td><td colspan="2">Course Type: Theory Integrated with Laboratory</td></tr>
<tr><td rowspan="6">Teaching Learning Process</td><td></td><td>Contact Hours/Semester</td><td colspan="4">Assessment Weightage and Marks</td></tr>
<tr><td>Lecture</td><td>45</td><td></td><td>CIE</td><td>SEE</td><td>Total</td></tr>
<tr><td>Tutorial</td><td>-</td><td>Weightage, %</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Practical</td><td>30</td><td rowspan="2">Maximum Marks</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">100</td></tr>
<tr><td>Self-learning & Term work</td><td>45</td></tr>
<tr><td>Total</td><td>120</td><td>Minimum Marks</td><td>20</td><td>25</td><td>45*</td></tr>
</table>

Note: *For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Pre-Requisite: First-year Engineering Chemistry Theory and Laboratory, Engineering Physics, and Engineering Mechanics.

Course Objective: The students gain knowledge on concepts in chemistry for analyses; apply learned concepts to water/wastewater treatment and other environmental attributes; understand the usefulness and importance of equations, stoichiometrically solve numerical problems relating to environmental chemistry addressing environment aspects/attributes of the society for its protection from pollution/contamination.

Course Outcomes (COs):

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Explain the concepts of chemistry and equations for various quantitative analyses of drinking water.	**L2**	1, 3
CO2	Apply Stoichiometric analyses to solve real-time problems and to address the impacts of pollution.	**L3**	2, 3, 6
CO3	Apply the concepts of environmental chemistry to remediate polluted and contaminated sites in the field, interpret and state the solution.	**L3**	4, 6, 8
CO4	Comprehend the environmental significance of pollution parameters and their interactions with components of the environment.	**L3**	1, 5, 7, 9
CO5	Demonstrate green chemistry concepts/skills to continually address society- environment-related problems and arrive at logical decisions	**L3**	2, 4, 5, 7, 8, 9

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

Course Syllabus:

Unit No.	Content	Lecture hours
1	Introduction -Scope and Significance of Environmental Chemistry. Properties of Chemical Compounds - Molecular weight, Equivalent weight, Molecular volume, Critical volume, Boiling point, Melting point, Density - Numerical exercises. **Self-Learning and Term work** ● Numerical /analytical tasks ● Problem solving ● Case study	**06**
2	Physical Chemistry- Oxidation, Reduction, Osmosis, Dialysis, Solvent Extraction, Catalysis, Absorption, Adsorption and Isotherms, Ion exchange, Electro Dialysis. Colorimetry-Beer's Law and Lamberts Law, Electrochemistry. Applications and numerical problem-solving in Environmental Engineering. **Self-Learning and Term work** ● Case Study ● Quiz/Debate ● Model making	10
3	Equilibrium Chemistry- Introduction, Acids, Bases, Buffers, Buffer index. Numerical problems on pH neutralization. Colloidal Chemistry - Colloidal dispersion in water and air attributes. Biochemistry - Enzymes, Cofactors, Biochemistry of Carbohydrates and Proteins, Biochemical Pathways, Enzyme reactions. **Self-Learning and Term work** ● Numerical /analytical tasks ● Problem solving ● Case study	**10**
4	Environmental Characteristics of Organic Compounds - Saturation concentration, Solubility, Octanol Water partition coefficient. Hydrolysis, Photolysis, Volatilization and Decay, Half-life concept. Organic Chemistry - Aliphatic, Aromatic, Carboxylic, Heterocyclic compounds, Fats, Oil and Detergents. Chemical Thermodynamics - Free Energy Formation, Entropy Formation, Ionic Strength considerations, Theoretical Equations for Active Coefficient, Simultaneous Reactions, Factors affecting Equilibrium concentration and Temperature effects - Numerical exercises. **Self-Learning and Term work** ● Case Study ● Quiz/Debate ● Model making	**11**
5	Environmental Significance of Pollution Parameters - Temperature, Color, pH, Hardness, Iron, Manganese, Fluoride, Nitrogen, Phosphorous, Carbon, Sulphate, DO, BOD, COD, TOC, TOD, THOD; Related equations and Numerical exercises. Green Chemistry - Goals, Principles of Green Chemistry, Sustainable Chemistry, Hierarchy.	**08**

	Self-Learning and Term work ● Lab component (Field work) ● Numerical /analytical tasks ● Case study/ Group event	

Note: Components in SL and TW shall be assessed in CIE only.

Week	List of Experiments	Hours
1	Introduction to laboratory, Sampling Techniques and Preservation of Samples	02
2	Temperature, Dissolved Oxygen (DO)	02
3	Turbidity, Color (Apparent and true)	02
4	Total solids and Volatile solids	02
5	Alkalinity and Hardness	02
6	Chloride, Conductivity and pH	02
7	Iron and Manganese	02
8	Sodium and Potassium	02
9	Phosphate and Nitrate	02
10	Chloride and Sulphate	02
11	Fluoride	02
12	Trace contaminants (Heavy metals and Pesticides)	02
13	Revision	02
14	Review / Revision of experiments	02
15	CIE final assessment	02

Text Books:

- Sawyer G.N., Mc Carty P.L., and Parkin G. F, "Chemistry for Environmental Engineering and Science", 5th Edition, Tata Mc Graw Hill publications. 2003.
- Manohar S.E., "Fundamentals of Environmental Chemistry", 3rd edition Taylor and Francis / CRC Press. 2009.

Reference Books:

- Treybul R.E. "Mass Transfer Operation", McGraw Hill publications, Kogakusha. 1960.
- Michael P.N. "Ecology", CBS Publishers and Distributors. New Delhi. 2016.
- Stumn and Morgan. "Aquatic Chemistry", 2nd Edition, John Wiley publications.1981.
- Morrison and Boyd, "Organic Chemistry", 7th edition, Eastern Economy Edition, Pearson, India. 2011.
- APHA. "Standard Methods for Examination of Water and Wastewater", Washington DC. 24th Edition.
- Manual on water and wastewater analysis, NEERI, Nagpur.
- Technical articles from peer-reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis, and patented materials.

Journals/Magazines:

- https://www.springer.com/journal/10311
- https://www.tandfonline.com/toc/geac20/current

- https://www.sciencepublishinggroup.com/journal/index?journalid=292

Web/Digital Sources

- https://www.beyondbenign.org/news-virtual-resources/
- https://chem.libretexts.org/Bookshelves/Environmental_Chemistry/Green_Chemistry_and_the_Ten_Commandments_of_Sustainability_(Manahan)

SWAYAM/NPTEL

- https://onlinecourses.nptel.ac.in/noc23_bt07/preview

Course Articulation:

COURSE OUTCOMES↓	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	-	3	3	3	3	-	3	3	-	3	2	3
CO2	3	3	-	3	3	3	3	2	3	3	-	3	3	3
CO3	3	3	-	3	-	3	3	-	3	3	-	3	3	3
CO4	3	3	-	-	-	3	3	-	-	3	-	3	3	3
CO5	3	3	1	3	3	3	3	2	3	3	-	3	3	3

High – 3, Medium – 2, Low – 1

Department: Environmental Engineering						
Course Code: 24EV320		***Course Title: Environmental Fluid Mechanics-I***				
Total Credits: 4 L-60; T-0; P-0; SL&TW: 60		***SDGs addressed: 6, 8, 9, 12, 17***	***Course Category: PCC***		***Course Type: Theory***	
Teaching Learning Process		***Contact Hours/Semester***	***Assessment Weightage and Marks***			
	Lecture	***60***		***CIE***	***SEE***	***Total***
	Tutorial	***-***	***Weightage, %***	***40***	***60***	***100***
	Practical	***-***	***Maximum Marks***	***40***	***60***	***100***
	Self-learning & Term work	***60***				
	Total	***120***	***Minimum Marks***	***20***	***25***	***45****

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Pre-Requisite: Engineering Physics, Engineering Chemistry, and Engineering Mathematics-I & II

Course Objective: Students will be able to understand basic concepts underlying hydraulics as applied to fluid properties, pressure measurement, hydrostatics, kinematics, fluid dynamics, and impact of fluid flow in pipelines/open channels - for application to address Environmental Engineering problems of society.

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Explain the basic properties and classification of fluids.	**L2**	1, 3
CO2	Determine the fluid pressure and use various devices for measuring fluid pressure.	**L3**	2, 3, 6
CO3	Calculate hydrostatic force and use of the law of conservation mass to fluid flow.	**L3**	2, 3, 4, 6, 8
CO4	Use of Bernoulli's equation to fluid flow problems.	**L3**	3, 4, 6, 7, 9
CO5	Explain the concept of dimensional analysis and similitude for hydraulic Models	**L3**	2, 4, 5, 7, 8, 9

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Syllabus:

Unit No.	Content	Hours Lecture
1	**Fluid Properties and Classification - Fluids** and Continuum, properties of Fluids, Newtonian and Non-Newtonian fluids: applications, Capillarity. Newton's law of Viscosity, Surface Tension – Numerical exercises. **Self-Learning and Term work** ● Explore dynamic and kinematic viscosity, Newtonian vs. non-	**12**

	Newtonian fluids, and real-world applications (e.g., oil vs. water). ● Surface Tension and Capillarity Study how intermolecular forces affect fluid surfaces and phenomena like water rising in a thin tube. ● Newtonian vs. Non-Newtonian Fluids Study how shear stress relates to shear rate—think honey vs. ketchup.	
2	**Fluid Pressure and Measurement -** Pressure at a point, Pascal's law, Hydrostatic pressure law, Pressure-density-height relationship. Absolute and Gauge pressure, Manometers, and types -Numerical exercises. **Self-Learning and Term work** ● Pressure-density-height relationship ● Calculate pressure at a given depth in water ● Determine pressure difference between two points	**12**
3	**Hydrostatics -** Pressure - Equation for hydrostatic force, depth of the centre of pressure on plane surfaces (vertical and inclined), inclined surfaces, vertically submerged and curved surfaces- Numerical exercises. **Kinematics of Fluids -**Types and classification of flow, Lagrangian and Eulerian approaches. Path line, streamline, streak line, stream tube. 1-D flow, Continuity equation in differential form. Velocity potential, Stream functions and relationship, Equipotential line, –Numerical exercises. **Self-Learning and Term work** ● Calculate force on a submerged gate ● Find depth of pressure center on a vertical wall ● Types and Classification of Flow	**15**
4	**Dynamics of Fluid Flow -**Concept of Inertia, derivation of Euler's and Bernoulli's equations – limitations, modification of Bernoulli's equation - problems and applications of Bernoulli's equation - Pitot tube and Venturi meter, Momentum equation - Numerical exercises. **Self-Learning and Term work** ● Euler's - Apply to pressure gradient in inviscid flow ● Bernoulli's equations -Calculate velocity or pressure at different points ● Venturi meter - Compute flow rate from pressure difference	**12**
5	**Dimensional Analysis and Model Similitude -** Units, Scale effects, Dimensional Homogeneity, Methods of Analysis, Model Studies, Similitude, Dimensionless parameters. Froude's and Reynold's models – Numerical exercises. **Self-Learning and Term work** ● Dimensional Homogeneity: Verify correctness of fluid	**09**

	equations ● Similitude: Determine model scale for dynamic similarity ● Froude's and Reynold's models : Apply scaling laws to prototype prediction	

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

- Modi P. N. and Seth S. M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi. 2013.
- Subramanya K. "Fluid Mechanics and Hydraulic Machines- Problems and Solutions", Tata Mc Graw Hill Publishing Co. Ltd. New Delhi. 2005.

Reference Books:

- Som S. K. and Biswas G. "Introduction to Fluid Mechanics and Fluid Machines", Tata Mc Graw Hill, New Delhi. 2007.
- Arora K. R., "Fluid Mechanics, Hydraulics and Hydraulic Machines", Standard Publishers Distributors, New Delhi. 2010.
- Bansal R. K. "Fluid Mechanics and Hydraulic Machines", Lakshmi Publications, New Delhi. 2011.
- Technical articles from peer-reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis, and patented materials.

Journals/Magazines: Technical articles from peer-reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources:

- Fluid Mechanics virtual labs. https://eerc03-iiith.vlabs.ac.in/

SWAYAM/NPTEL:

- https://nptel.ac.in/courses/112105269
- https://archive.nptel.ac.in/courses/112/104/112104118/

Course Articulation:

COURSE OUTCOMES↓	PROGRAM OUTCOMES											Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	-	-	-	-	-	-	3	3	3
CO2	3	3	3	3	1	-	-	-	-	-	-	3	3	3
CO3	3	3	3	3	-	-	-	-	-	-	-	3	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	3	3	3
CO5	3	3	3	3	-	-	-	-	-	-	-	3	3	3

High – 3, Medium – 2, Low – 1

<table>
<tr><td colspan="7">Department: Environmental Engineering</td></tr>
<tr><td colspan="3">Course Code: 24EV330</td><td colspan="4">Course Title: Environmental Microbiology and Ecology</td></tr>
<tr><td colspan="3">Total Credits: 4
L-60; T-0; P-0; SL&TW: 60</td><td>SDGs addressed: 3, 6, 7, 9, 11, 12, 13, 14, 15</td><td colspan="2">Course Category: PCC</td><td>Course Type: Theory</td></tr>
<tr><td rowspan="6">Teaching Learning Process</td><td></td><td>Contact Hours/Semester</td><td colspan="5">Assessment Weightage and Marks</td></tr>
<tr><td>Lecture</td><td>60</td><td colspan="3"></td><td>CIE</td><td>SEE</td><td>Total</td></tr>
<tr><td>Tutorial</td><td>-</td><td colspan="3">Weightage, %</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Practical</td><td>-</td><td colspan="3" rowspan="2">Maximum Marks</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">100</td></tr>
<tr><td>Self-learning & Term work</td><td>60</td></tr>
<tr><td>Total</td><td>120</td><td colspan="3">Minimum Marks</td><td>20</td><td>25</td><td>45*</td></tr>
</table>

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Pre-Requisite: Basic Science and Mathematics.

Course Objective: This course provides the student with the basics as well as application aspects of both microbiology and environmental ecological systems for Environmental Pollution Control.

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Classify micro-organisms; understand nutritional requirements and growth kinetics.	L2	1, 3
CO2	Apply the theoretical concepts of microbial indicators, and identification techniques and understand the importance of heavy metal uptake metabolism, Biocatalysis, and Enzyme reactions.	L2	3, 6
CO3	Understand Indoor microbial environment and symbiotic Interactions of microbes and analyze Bioaccumulation, Bio-concentration, and Bio-magnification effects.	L3	4, 6, 8
CO4	Analyze interrelationships of abiotic and biotic components of ecosystems and understand the ecological pyramids and related models.	L2	1, 5, 7, 9
CO5	Apply the knowledge of various diversity and dominance indices for water quality assessments and to assess pollution inputs to lakes.	L4	2, 4, 5, 7, 8, 9

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Syllabus:

Unit No.	Content	Lecture hours
1	Microbiology and its Environmental Significance, Microbial Diversity in the Environment- Bacteria, Fungi, Algae, Protozoa and Virus; Microbial Infectious Diseases, Bacterial growth curve, Monod's equation and Michali's - Menton equation with numerical problems, Microbial interactions and its industrial applications. **Self-Learning and Term work** ● Numerical /Analytical tasks ● Problem solving/ Case study ● Microbial Genetics	**14**
2	Bio-indicators of Surface and Ground Water contamination - Indicator microorganisms, TC, FC, FS. Plate count, MTFT and MFT - Determination of MPN using Thomas formula and Standard methods, comparison with MPN table (Lab component). Metabolism, Catabolism and Anabolism - Microbial metabolism of Heavy metals and Pesticides. Bio-catalysis - Enzymes and Enzymatic reactions for Environmental applications. **Self-Learning and Term work** ● Lab component (Field work) ● Numerical /Analytical tasks ● Case study/ Group event	**10**
3	Indoor microbial environment - air changes per hour (Lab component). Status of lakes- oligotrophy to eutrophy and beyond – prevention and control. Restoration of lakes. Symbiotic Interactions of microbes- Interactions with Environment and Nutrient Cycling. Algae and weed control, Bio-accumulation, Bio-concentration, Biomagnification. **Self-Learning and Term work** ● Hand-on Demonstration/Model making ● Poster presentation ● Case study/ Group event/Debate	**10**
4	Scope of Ecology, sub-divisions, Ecological Terminology, Ecosystems – Classification, biotic and abiotic components, elementary cybernetics of ecosystems, energy flow, Eltonian pyramids, Lotic and Lentic Ecosystems, Lake Stratification, Lindeman's model, productivity and measurement. **Self-Learning and Term work** ● Case Study ● Quiz/Debate ● Model Making	**14**
5	Limiting factors, Liebig's law, Shelford's law of tolerance, Systems Ecology and Ecosystems' modelling. Biodiversity and ecological perspective – human benefits, threats, conservation, preservation and protection. Diversity index, Dominance, unevenness and similarity indices – numerical problems.	**12**

	Self-Learning and Term work ● Problem solving ● Numerical /Analytical tasks ● Tools and models- run & test	

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

- Odum E.P. and Barrett G. W. "Fundamentals of Ecology", Cengage publisher. 2004.
- Kormondy. E. J. "Concepts of Ecology". Pearson Publisher, 4th Edition. 1996.

Reference Books:

- Pradipta K Mohapatra., "Text book of Environmental Microbiology". I.K International publishing house Pvt. Ltd. 2008.
- McKinney R.E.," Microbiology for Sanitary Engineers". McGraw Hill.
- Raina. M. Maier. Ian L Pepper and Chales P Gerba." Environmental Microbiology" – 2nd edition, Elsevier. 2008.
- Verma P.S and Agarwal V. K. "Concept of Ecology", S. Chand & Company Ltd. 1998.

Journals/Magazines: Technical articles from peer-reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources:

- YouTube links

SWAYAM/NPTEL:

- Applied Environmental Microbiology- Prof. Gargi Singh, IIT Roorkee, https://onlinecourses.nptel.ac.in/noc23_ce10/preview

Course Articulation:

COURSE OUTCOMES↓	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	-	3	3	-	-	-	-	-	-	3	-	2
CO2	3	3	-	3	3	2	-	-	3	-	-	3	2	-
CO3	3	3	-	3	3	-	-	-	3	-	-	3	-	2
CO4	3	-	-	-	3	2	-	-	-	-	-	3	2	-
CO5	3	3	-	3	3	-	-	-	3	-	-	-	-	-

High – 3, Medium – 2, Low – 1

Department: Environmental Engineering						
Course Code: 24EV340		***Course Title: Elements of Environmental Engineering***				
Total Credits: 3 L-45; T-0; P-0; SL&TW: 45		***SDGs addressed: 6, 7, 13, 14, 15***	***Course Category: PCC***		***Course Type: Theory***	
Teaching Learning Process		***Contact Hours/Week***	***Assessment Weightage and Marks***			
	Lecture	***45***		***CIE***	***SEE***	***Total***
	Tutorial	***-***	***Weightage, %***	***40***	***60***	***100***
	Practical	***-***	***Maximum Marks***	***40***	***60***	***100***
	Self-learning & Term work	***45***				
	Total	***90***	***Minimum Marks***	***20***	***25***	***45****

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20+25 or 21+24)

Course Pre-Requisite: Basic knowledge of Environmental Studies

Course Objective: The students gain engineering knowledge on elements of the environment, and sources of pollution/contamination; understand and analyze environmental-related problems for application in the society following a code of ethics.

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Explain the basic elements/concepts of various attributes to ethically protect the Environment.	L2	1, 3, 9
CO2	Analyze various sampling protocols, land use zoning to address /communicate Environmental problems to society (rural and urban).	L4	2, 3, 6
CO3	Identify the point and non-point source of pollution and initiate steps to safeguard Environment for sustainability and to address noise measurements with numerical problems.	L3	2, 3, 4, 6, 8
CO4	Summarize assimilative and supportive capacities of environment and to illustrate the waste management practices.	L2	1, 4, 5, 6, 7
CO5	Engage in applying critical thinking skills to continually address society related problems and find appropriate solutions.	L3	5, 7, 8, 9

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

Course Syllabus:

Unit No.	Content	Lecture hours
1	**Introduction:** Environmental Pollution and its Types**,** Human Ecology – Relationships with Environment, Role of Environmental Engineers in Environmental Protection, Code of Environmental Ethics, economic growth	**09**

	and Environmental quality, Indian Environmental Legislation. Organizations involved in Environmental Protection, Environmental footprints. Mass Balance Approach- Numerical problems. **Self-Learning and Term work** ● CPCB guidelines for air, water, and noise ● Wastewater discharge standards ● Case studies	
2	**Urban and Rural Ecosystems** - Land use pattern and Landscape, Zoning regulation for different land users and externalities caused by mixed land uses, Special Economic Zone (SEZ), Coastal Regulation Zone (CRZ), Urban green belt concept, Rainwater Harvesting - necessity and types, Environmental Sampling – Sampling Types and its importance. Pollutant-soil interactions. Classification of Environmental Contaminants and Pollutants – Industrial emissions, Transportation, construction, and mining activities. **Self-Learning and Term work** ● Lab component (Environmental sampling) ● Field visit ● Land use zoning guidelines	**09**
3	**Point Sources and Non-Point Sources of Pollution-** Air, water, and land attributes – Pollutant/contaminant interactions between attributes and externalities. NPS prevention & control. **Characteristics of Noise Pollution from Point and Non-Point Sources –** Noise – Urban, Rural, and Industrial sources. Transport network, construction and mining activities, Industrial Noise.; Leq concepts, background noise, standards. Power, pressure, and Intensity of noise. Noise characteristics – Numerical problems. **Self-Learning and Term work** ● Lab component (Noise monitoring) ● Field visit ● numerical /analytical tasks	**09**
4	**Environmental Systems -** Assimilative, Supportive, and Carrying Capacity. Environmental Indices. Environmental Sustainability – Resource depletion and Environmental degradation – Control strategies. Biodiversity – Concept and Importance. Renewable and Non-Renewable Natural Resources. **Solid waste Management**– Municipal, Biomedical, Hazardous and E-waste. **Self-Learning and Term work** ● Community outreach activities ● Numerical /Analytical tasks ● SDG	**09**
5	**Sub-surface Pollutant Sources -** Septic tanks, soak pits, and dispersion trenches. Low-cost sanitation systems. **Recent Trends**- Prevention of Significant Deterioration, Pollution Prevention Hierarchy. Proactive and Passive Environmental management,	**09**

	Emerging Environmental problems **Self-Learning and Term work** ● Case study ● numerical /analytical tasks ● Mini project/field	

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

- Richard O. Mines John Wiley and Sons, "Environmental Engineering Principles and Practice". USA, New York, 2014
- Gilbert M. Masters, "Introduction to Environmental Engineering Science", 5th Edition. Prentice Hall of India. New Delhi, 2005
- Tchobanoglous G, Theisen H., and Vigil S. "Integrated Solid Waste Management - Engineering Principles and Management Issues", McGraw Hill Inc., New York.

Reference Books:

- William W Nazaroff and Lisa Alvarez-Cohen, "Environmental Engineering Science". John Wiley & Sons, New Delhi 2010.
- Verma P.S. and Agarwal V.K., "Concept of Ecology", S. Chand & Company Ltd. Roorkee. 1998.
- Metcalf and Eddy, "Wastewater Engineering - Treatment and Reuse" 4th Edition, Tata Mc Graw Hill Publishing Co. Ltd., New Delhi.
- APHA, "Standard Methods for Examination of Water and Wastewater", Washington DC. 24th Edition.

Journals/Magazines: Technical articles from peer-reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis, and patented materials.

Web/Digital resources:

- YouTube links

SWAYAM/NPTEL:

- Air Pollution and Control by Prof. Bhola Ram Gurjar, IIT Roorkee https://onlinecourses.nptel.ac.in/noc23_ce14/preview

Course Articulation:

COURSE OUTCOMES↓	Program Outcomes											Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	-	-	3	-	-	-	3	-	3	3	-	-
CO2	3	3	-	3	3	-	-	-	3	-	3	3	3	3
CO3	3	3	-	3	3	-	-	-	3	-	-	3	3	3
CO4	3	3	1	3	3	1	2	-	-	-	3	3	3	3
CO5	3	3	-	3	3	-	2	-	3	-	3	3	-	-

High – 3, Medium – 2, Low – 1

Department: Environmental Engineering						
Course Code: 24EV350		**Course Title: Construction Engineering Materials**				
Total Credits: 3 **L-45; T-0; P-0; SL&TW: 45**		**SDGs addressed: 7, 9, 11, 12**	**Course Category: PCC**		**Course Type: Theory**	
Teaching Learning Process		**Contact Hours/Semester**	**Assessment Weightage and Marks**			
	Lecture	**45**		**CIE**	**SEE**	**Total**
	Tutorial	**-**	**Weightage, %**	**40**	**60**	**100**
	Practical	**-**	**Maximum Marks**	**40**	**60**	**100**
	Self-learning & Term work	**45**				
	Total	**90**	**Minimum Marks**	**20**	**25**	**45**

Note: For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20+25 or 21+24)

Course Pre-Requisite: Strength of Materials

Course Objective: The course will expose the student to various facets of construction engineering, conventional, non-conventional, and eco-friendly engineering materials and their functional properties.

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Describe various components of the building, their functional requirements, types of building stones, and the differences between various aggregates based on properties.	L1	1, 3
CO2	Explain the manufacturing, types, engineering properties, and testing of various construction materials.	L2	3, 8
CO3	Discuss on the application of allied materials in construction based on their properties and types.	L2	5, 7
CO4	Summarize the application of different types of foundations, and types of scaffoldings, identify mixing proportions, types of flooring finishes, and roofing.	L4	3, 5, 9
CO5	Apply critical thinking on potential non-traditional building materials and reuse in construction; waste resource recovery.	L4	5, 8, 9

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Syllabus:

Unit No.	Content	Lecture hours
1	Functional requirements of a building, components of the building, Building Stones - Common building stones - Quarrying, Dressing, Deterioration, and Preservation techniques. Aggregates - Coarse and Fine aggregates (Msand) – properties.	**09**

	Self-Learning and Term work ● Origin and mineral composition of different types of stones ● Construction applications of different types of stones ● Decorative components of a building	
2	Bricks - Types and classification, Manufacturing and testing. Hollow and solid fly ash concrete blocks. Tiles - Types, quality, and testing. Timber - Types, properties, Methods of Seasoning, Plywood, and alternate materials – preservatives. Cement: Types, composition and properties, and tests. IS codes for construction materials **Self-Learning and Term work** ● Practical testing of bricks ● Cost aspects (market price of all materials) ● Sulfate attack on cement	**09**
3	Allied Construction materials - Properties and use of Reinforcing steel, Structural steel, Glass, Electrical, Thermal, and Sound Insulating Materials, Paints, Plumbing materials, Rubber, Bitumen and Asphalt, Water proofing compounds. Metals: Frames, trusses, partitions, etc. **Self-Learning and Term work** ● Cost aspects (market price of all materials) ● Environmental impacts of paints ● Environment friendly allied materials	**09**
4	Construction Engineering - Earthwork and foundation in different types of soils; Scaffolding types and materials. Mixing proportions - stone and brick masonry; Cement mortar. Cement concrete, ready mix concrete, Reinforced concrete, pre-stressed concrete, fiber reinforced concrete; Plastering, flooring-different types, Roof types. **Self-Learning and Term work** ● Construction site visit ● Mortar Mix Type: N, O, S, or M ● Cost aspects of flooring and roofing materials	**09**
5	Recent trends – Green Building materials, fabricated timber, Floating concrete and permeable pavements, Composite materials. Low-cost construction materials. Waste reuse in construction. Prefabricated Package Units for environmental engineering applications. Aluminum shuttering, self-compacting cement concrete. **Self-Learning and Term work** ● Case studies on green buildings ● Case studies on low cost construction ● Case studies on waste utilization in construction	**09**

Note: Components in SL and TW shall be assessed in CIE only.

Text Books

- Sushil Kumar. "Engineering Materials". Standard Publication and Distributors, New Delhi. 2010.
- Varghese P. G., "Building Materials", 2nd edition, Prentice Hall of India Pvt. Ltd. New Delhi. 2011.

Reference books

- Neville A. M. and Brooks J. J. "Concrete Technology". 2nd edition. Prentice Hall, New Delhi, 2010.
- Shetty M. S., "Concrete Technology - Theory and practice", S. Chand and Co, New Delhi, 2002.
- Manjunath K. S. "Materials of Construction", Sanguine Publishers, Bengaluru. 2010.
- Duggal S.K. "Building Materials".3rd revised Edition, New Age International publishers, New Delhi. 2008.
- Indian Standard codes for construction materials.
- Mohan Rai and Jain M. P. "Advances in Building Material and Construction" Singh Publication by CBRI, Roorkee, 2010.

Journals/Magazines

- Technical articles from peer-reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis, and patented materials.

Web/Digital resources:

- https://www.youtube.com/watch?v=gnkkRsn5Wsw
- https://www.youtube.com/watch?v=lSCz1fL7DzQ
- https://www.betonamit.com/html/expansive-cement.html
- https://www.youtube.com/watch?v=XYiRY5o99yQ
- https://www.youtube.com/watch?v=aYoDgfeHsII
- IS codes for construction materials: http://www.civilology.com/is-codes-list-in-civil-engineering/
- https://expertcivil.com/indian-standard-is-codes-list-pdf/

SWAYAM/NPTEL:

Basic construction materials by Prof. Manu Santhanam and Prof. Radhakrishna G. Pillai, IIT Madras.

Course Articulation:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	2	3	-	-	-	-	3	-	1
CO2	3	-	2	-	-	2	3	-	-	-	2	3	2	1
CO3	3	1	2	-	-	2	3	-	-	-		3	2	1
CO4	3	1	2	-	-	2	3	1	-	-	2	3	2	1
CO5	3	1	2	1	-		3	1	-	-	2	3	2	1

High – 3, Medium – 2, Low – 1

Department: Environmental Engineering						
Course Code: 24EV36L			*Course Title: Environmental Microbiology Laboratory*			
Total Credits: 1.5 L-0; T-0; P-45; SL&TW: 0		*SDGs addressed: 3, 6, 7, 9, 12, 13, 14, 15*	*Course Category: PCCL*	*Course Type: Laboratory*		
Teaching Learning Process		*Contact Hours/Semester*	*Assessment Weightage and Marks*			
	Lecture	*-*		*CIE*	*SEE*	*Total*
	Tutorial	*-*	*Weightage, %*	*40*	*60*	*100*
	Practical	*45*	*Maximum Marks*	*40*	*60*	*100*
	Self-learning & Term work	*-*				
	Total	*45*	*Minimum Marks*	*20*	*25*	*45**

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20+25 or 21+24)

Course Pre-Requisite: Water Quality Analysis Laboratory and Environmental Microbiology and Ecology

Course Objective: The lab course provides practical exposure to students on various qualitative and quantitative analytical methods for screening, identification, and quantification of microorganisms in different contaminated water samples.

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Explain different apparatus/instruments/equipment, chemicals, reagents, measurement techniques for various microbiological parameters, and applicable standards.	L2	1, 3
CO2	Use of various analytical methods for measuring different types of microorganisms and to compare the sensitivity of each method of analysis.	L2	1, 3, 6
CO3	Develop the ability to analyze, interpret, and infer analytical data at bench scale and pilot scale	L3	2, 4, 5, 6, 7, 8, 9

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

Course Syllabus:

Week	List of Experiments/ Programs	No. of Hours
1	Sterilization techniques, Apparatus/equipment used, washing and cleaning, Lab safety aspects, Water sampling protocols	3
2	Culture media – types and preparation	3
3	Bacteriological tests on water samples by the Agar Plate Count method	3
4	Bacteriological tests on water samples (TC, FC & FS) by the Multiple Tube Fermentation Test	6

5	Bacteriological tests on water samples (TC, FC & FS) by the Membrane Filter Technique	6
6	Bacteriological tests on water samples by the Rapid detection method	3
7	Staining technique	3
8	Detection of fungi in wastewater & Air samples	6
9	Microbial Identification in Soil Samples	3
10	Microbial Cells Immobilization Technique & Bioassay test (Theory and method of analysis)	3
11	Review/ Revision of experiments	3
12	Laboratory Test (CIE)	3

Reference Books:

- APHA, "Standard Methods for Examination of Water and Wastewater", 2018. 24th Edition.
- Pelczar M.J., Chan E.C.S. and Krieg, N.R. "Microbiology". Tata Mc Graw – Hill Publishing Company Ltd. 5th edition. New Delhi. 2008.
- Technical articles from peer-reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis, and patented materials.

Course Articulation:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	-	3	3	3	3	-	3	3	-	3	3	-
CO2	3	3	-	3	3	3	3	-	3	3	-	3	3	3
CO3	3	3	2	3	3	3	3	-	3	3	-	3	3	3

High – 3, Medium – 2, Low – 1

<table>
<tr><td colspan="7">Department of Humanities</td></tr>
<tr><td colspan="3">Course Code: 24HU312-24HU412</td><td colspan="4">Course Title: Environmental Studies</td></tr>
<tr><td colspan="3">Total Credits: 2
L-30; T-0; P-0; SL&TW: 30</td><td>SDGs addressed: 3, 6, 7, 9, 11, 12, 13, 14, 15</td><td colspan="2">Course Category: HSMC</td><td>Course Type: Theory</td></tr>
<tr><td rowspan="6">Teaching Learning Process</td><td></td><td>Contact Hours/Semester</td><td colspan="4">Assessment Weightage and Marks</td></tr>
<tr><td>Lecture</td><td>30</td><td></td><td>CIE</td><td>SEE</td><td>Total</td></tr>
<tr><td>Tutorial</td><td>-</td><td>Weightage,%</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Practical</td><td>-</td><td rowspan="2">Maximum Marks</td><td rowspan="2">20</td><td rowspan="2">30</td><td rowspan="2">50</td></tr>
<tr><td>Self-learning & Term work</td><td>30</td></tr>
<tr><td>Total</td><td>60</td><td>Minimum Marks</td><td>10</td><td>13</td><td>23*</td></tr>
</table>

Note: *For passing, the student has to score a minimum of 23 marks (CIE+SEE=10+13 or 11+12).

Course Pre-Requisite: NIL

Course Objective: The student gains knowledge on basic concepts on Environmental aspects and understands its importance in various disciplines for safeguarding the environment.

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Understand the principles of ecology and environmental issues that apply to air, land, and water attributes at regional and global scales.	L2	1, 3, 7
CO2	Develop critical thinking/observation skills - apply them to identify and analyze environmental issues.	L2	2, 3
CO3	Understand the complex ecological relationship between biotic and abiotic components.	L2	1, 4
CO4	Apply ecological knowledge to illustrate and address environmental problems for better management.	L2	3, 4, 5, 6, 7, 8
CO5	Understand the recent technologies and legal aspects related to the environment.	L2	5, 7, 8, 9

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

Course Syllabus:

UNIT No.	Content	Lecture Hours
1	Introduction: Environment - Components of Environment Ecosystem: Types & Structure of Ecosystem, Ecological principles, Difference between Ecology, Environment, and Ecosystem, Different types of energy -	**7**

	Conventional sources & Non-Conventional sources of energy Solar energy, Hydroelectric energy, Wind Energy, Nuclear energy, Biomass & Biogas Fossil Fuels, Hydrogen as alternative energy. **Self-Learning and Term work:** • Ecological Pyramids • Generations of biofuels • Bio-geochemical cycles.	
2	Natural Resources, Water resources – Availability & Quality aspects, Water borne diseases & water induced diseases, Fluoride problem in drinking water Mineral resources. Climate change - Global Warming, Acid rain, urban Heat Island & Ozone layer depletion, controlling measures. Deforestation – Causes, Implication for climate change, Economical Impacts, Strategies for reducing deforestation. Impacts of Agriculture – Pollution due to the use of chemical fertilizer, soil-related effects, and Emission of methane with relevant case studies. **Self-Learning and Term work:** • Positive feedback loop • Montreal Protocol • Kyoto Protocol	**7**
3	Environmental Pollution – Air Pollution, Water Pollution, Noise Pollution, Land Pollution, Public Health Aspects. Solid Waste Management, E - Waste Management & Biomedical Waste Management - Sources, Characteristics & Disposal methods. Effects of human activities on the environment. **Self-Learning and Term work:** • CPCB guidelines for air, water, and noise • Wastewater discharge standards	**6**
4	Sustainable Development – Principle of Sustainability, Measurement of sustainability, utilization of natural resources, Challenges to sustainable development. Biodiversity – Important kinds of biodiversity, Degree of diversity in an ecosystem, threats to biodiversity. **Self-Learning and Term work:** • Solving numerical problems on diversity indices • community outreach activities • Restoration strategies	**6**
5	Environmental Acts & Regulations - Air and Water Act, Environment related organization, Environment Impact Assessment, Role of Non-Governmental Organizations (NGOs), NGT. **Self-Learning and Term work:** • Amendments • Case studies • Visit NGO's and report preparation	**4**

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

- Benny Joseph. "Environmental Studies", Tata McGraw–Hill Publishing Company Limited. 2005.
- Ranjit Daniels R.J. and Jagadish Krishnaswamy. "Environmental Studies", Wiley India Private Ltd., New Delhi.2009.
- Rajagopalan R., "Environmental Studies – From Crisis to Cure", Oxford University Press, 2005.
- Aloka Debi, "Environmental Science and Engineering", Universities Press (India) Pvt., Ltd., 2012.

Reference Books:

- Raman Sivakumar, "Principals of Environmental Science and Engineering", 2nd Edition, Cengage Learning Singapore, 2005.
- Meenakshi P., "Elements of Environmental Science and Engineering", Prentice Hall of India Private Limited, New Delhi, 2006.
- Prakash S.M., "Environmental Studies", Elite Publishers Mangalore, 2007.
- Erach Bharucha, "Textbook of Environmental Studies", for UGC, University Press, 2005.
- Tyler Miller Jr G., "Environmental Science – working with the Earth", 11th Edition, Thomson Brooks, Cole, 2006.

Journals/Magazine

Technical articles from peer-reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis, and patented materials.

Course Articulation Matrix:

COs↓	PROGRAM OUTCOMES										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	3	-	--	-	-	3	-	3	3	-	3
CO2	3	1	-	2	-	3	-	3	3	-	3
CO3	3	-	-		-	3	3	3	3	-	3
CO4	3	-	-	2	-	3	3	3	3	-	3
CO5	3	-	-		-	3	3	3	3	-	3

High – 3, Medium – 2, Low – 1

4th Semester

Syllabus

IV Semester
(Non-Credit Course)
(For Lateral Entry Students)

DEPARTMENT	**Mathematics**						
Course Code	**24MATDIP410**	*Total Credits*	**00**	*Course Type*	**Theory (Basic Science Course)**		
Course Title	**Foundations of Engineering Mathematics-II (For IV Semester Lateral Entry Students)**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**03**	**00**		**CIE**	**SEE**	**Total**
	Tutorial	**00**	**00**	*Weightage*	**-**	**100%**	**100%**
	Practical	**--**	**--**	*Maximum Marks*	**-**	60	**60 Marks**
	Total	**03**	**00**	*Minimum Marks*	**-**	24	**24 Marks**

Pre requisites: Basics in differential calculus, Integral calculus and vectors.

Course objective: This course will enable students to:

1. Solve second and higher order differential equations.
2. Find the Laplace transform of the function f(t).
3. Find the Inverse Laplace transform of the function F(s).
4. Apply the knowledge of numerical methods in the models of various physical and Engineering phenomena.
5. Solve the integral by using standard integrals (Beta and Gamma) and multiple integrals.

Course Outcomes: After the completion of this course, students will be able to:

CO#	Course Outcome	Highest Level of Cognitive Domain
CO1	Explain various physical models through higher order differential equations and solve such linear ordinary differential equations.	L2
CO2	Understand the concept of Laplace transform and obtain Laplace transform of periodic functions and unit step functions.	L2
CO3	Apply the concept of Laplace transform in solving Linear Differential equations.	L2
CO4	Apply the Numerical methods to solve Algebraic and transcendental equations and find the polynomials by finite difference method.	L2
CO5	Apply the concept of to evaluate multiple integrals and Beta and Gamma functions	L2

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Syllabus:

UNIT No.	Content	Lecture Hours
UNIT 1	**Linear Differential Equations:** Solution of second and higher order equations with constant coefficients by inverse differential operator method, method of variation of parameters.	8
UNIT 2	**Laplace Transform:** Definition, Transforms of elementary functions, properties of Laplace Transform, Laplace Transform of $e^{at} f(t), t^n f(t), \frac{f(t)}{t}$, derivatives and Integrals. Laplace Transform of Periodic functions.	8
UNIT 3	**Inverse Laplace Transform:** Inverse Laplace Transform, Convolution theorem (without proof) and problems. Applications – Solution of Linear differential equations using Laplace Transform.	7
UNIT 4	**Elementary Numerical Methods:** Finite differences. Interpolation/extrapolation using Newton's forward and backward difference formulae, Newton's divided difference and Lagrange's formulae (All formulae without proof). Solution of polynomial and transcendental equations - Newton-Raphson method (only formula) – Illustrative examples.	8
UNIT 5	**Integral Calculus:** Multiple integrals –Evaluation of double and triple Integrals, Beta and Gamma functions: Definition, relation between Beta and Gamma functions and simple problems.	8

Text Books:

Sl. No	Author/s	Title	Publisher Details
1	B.S. Grewal	Higher Engineering Mathematics	44th Edition, 2015, Khanna Publishers, ISBN: 978- 81-933284-9-1.
2	E. Kreyszig	Advanced Engineering Mathematics	10th Edition (Reprint), 2016, John Wiley & Sons, ISBN: 978-0470458365
3	M.K. Jain, S.R.K. Iyenger and R.K. Jain	Numerical methods for scientific and engineering computation	6th Edition, 2012, New Age International Publishers, ISBN: 9788122433234, 8122433235

Reference Books:

Sl.No.	Author/s	Title	Publisher Details
1	N. P. Bali and Manish Goyal	A Textbook of Engineering Mathematics	Vol. I & II (AICTE), 10th Edition, Laxmi Publications Pvt Ltd, 2019, ISBN: 9789352743766, 9789352743766.
2	Maurice D. Weir, Joel R. Hass and George B. Thomas,	Thomas' calculus: Early Transcendentals	12^{th} edition, Pearson Education, 2016. ISBN: 978-07802-426-9.
3	B. V. Ramana	Higher Engineering Mathematics	11th edition, Tata-McGraw Hill, 2010, ISBN:0-07-053516-7.
4	Peter V.O 'Neil	Advanced Engineering Mathematics	7th edition, CENGAGE Learning India Pvt. Ltd. Publishers, 2012, ISBN: 978- 81-315-0310-2.

Web/Digital resources:

Sl. No.	Web Link
1	https://www.classcentral.com/subject/maths
2	https://academicearth.org/

Course Articulation Matrix:

POs → COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3										
CO2	3										
CO3	3										
CO4	3										
CO5	3										

High – 3, Medium – 2, Low – 1

PO1: ability to apply knowledge of Mathematics

FOURTH SEMESTER						
Course Code: 24MA411		Engineering Mathematics-IV (Common to CV, MECH, IP, ENV, CTM and PST)				
Total Credits: 03 *L-45: T-0: P-0: SL and TW-45*		*SDGs addressed:* *4, 5, 9, 16, 17*		*Course Category:* *Basic Science Course*		*Course Type: Theory*
Teaching Learning Process		*Total Contact Hours/semester*	*Assessment Weightage and Marks*			
	Lecture	45		CIE	SEE	Total
	Tutorial	-	*Weightage %*	*40*	*60*	*100*
	Practical	-	*MaximumMarks*	*40*	*60*	*100*
	Self-learning and Teamwork	45	*MinimumMarks*	*20*	*25*	*45**
	Total	90				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Pre-Requisite: Engineering Mathematics-I, II and III

Course Objective: This course will enable students to:

1. To develop and conduct appropriate experimentation, analyze and interpret data and use engineering judgment to draw conclusion.
2. To introduce the basic concepts and applications of probability in engineering.
3. Provide the knowledge about the random variable, random process and how to model the random processes in engineering.
4. Deal with multiple random variables and introduction of the most important types of stochastic processes.
5. To investigate the variability in sample statistics from sample to sample, measure of central tendency & dispersion of sample statistics and pattern of variability of sample.

Course Outcomes (COs): After the completion of this course, students will be able to:

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Apply least square method to fit a curve for the given data and evaluate the correlation coefficient and regression lines for the data.	L2	WK1, WK3
CO2	Analyze the nature of the events and hence determine the appropriate probabilities of the events.	L2	WK2, WK4
CO3	Classify the random variables to determine the appropriate probability distributions	L2	WK1, WK3
CO4	Determine the joint probability distribution, its mean, variance and covariance. Calculate the transition matrix and fixed probability vector for a given Markov chain.	L3	WK4, WK8
CO5	Estimate the parameter of a population, important role of normal distribution as a sampling distribution.	L2	WK2, WK9

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Statistics:** Introduction, Definitions, Curve Fitting: Straight line, parabola and exponential curves. Correlation and regression, formula for correlation coefficient, regression lines and angle between the regression lines. **Self-Learning and Term work** • Fitting of Exponential curve $y=ab^x$ • Describe the principle of least squares	**09**
2	**Probability:** Basic terminology, Definition of probability, Probability and set notations, Addition law of probability, independent events, conditional probability, multiplication law of probability, Baye's theorem. **Self-Learning and Term work** • Recapitulation of set theory • Empirical definition of probability	**09**
3	**Random Variables:** Discrete Probability distribution, Continuous Probability distribution, expectation, Variance, Probability generating function, Binomial distribution, Poisson distribution, Normal distribution. **Self-Learning and Term work** • Discrete and Continuous random variables: Definitions, Examples • Derive Mean and Standard Deviation of the Poisson Distribution • Application of Normal Distribution	**09**
4	**Joint probability distribution:** Joint probability distribution, Discrete and independent random variables, Expectation, Covariance, Correlation coefficient. Probability vectors, stochastic matrices, fixed point matrices, Regular stochastic matrices, Markov chains, Higher transition-probabilities, stationary distribution of regular markov chains and absorbing states. **Self-Learning and Term work** • Examples on continuous random variables • Classification of Stochastic Processes: Discrete state process, continuous state process • Examples of Finding Stationary Distribution of Markov Chain	**09**
5	**Sampling Distribution:** Introduction, Objectives, sampling distribution, testing of hypothesis, level of significance, confidence limits, simple sampling of attributes, test of significance of large samples, comparison of large samples, sampling of variables, central limit theorem, confidence limits for unknown mean, test of significance for means of two large samples, Sampling of variables – small samples, Student's t-distribution. **Self-Learning and Term work** • Real life examples for statistical inference • Test of significance for difference of means	**09**

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

Sl. No	Author/s	Title	Publisher Details
1	B.S. Grewal	Higher Engineering Mathematics	44th Edition, Khanna Publishers, 2015
2	Ralph P. Grimaldi	Discrete and Combinatorial Mathematics	4th Edition, PHI/Pearson Education, 2005
3	E. Kreyszig,	Advanced Engineering Mathematics	10th Edition (Reprint), John Wiley & Sons, 2016

Reference Books:

Sl.No.	Author/s	Title	Publisher Details
1	N. P. Bali and Manish Goyal	A Textbook of Engineering Mathematics	Vol. I & II (AICTE), 10^{th} Edition, Laxmi Publications Pvt Ltd, 2019
2	Alan Tucker	Applied Combinatorics	5th Edition, Wiley-India, 2011
3	Maurice D. Weir, Joel R. Hass and George B. Thomas	Thomas' calculus: Early Transcendentals,	12^{th} edition, Pearson Education, 2016
4	B. V. Ramana	Higher Engineering Mathematics	11th edition, Tata-McGraw Hill, 2010
5	Peter V.O 'Neil	Advanced Engineering Mathematics	7^{th} edition, CENGAGE Learning India Pvt. Ltd. Publishers, 2012

Web/Digital resources:

Sl.No.	Web Link
1	https://www.classcentral.com/subject/maths
2	https://academicearth.org/

Course Articulation:

POs → COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3										
CO2	3										
CO3	3										
CO4	3	1									
CO5	3										

High – 3, Medium – 2, Low – 1

PO1: ability to apply knowledge of Mathematics

PO2: ability to analyze engineering problems

Department: Environmental Engineering						
Course Code: 24EV410		***Course Title: Environmental Fluid Mechanics-II***				
Total Credits: 4 L-45: T-0: P-30: SL and TW-45		***SDGs addressed: 6, 11, 14***	***Course Category: PCC***		***Course Type: Theory Integrated with Laboratory***	
Teaching Learning Process		***Total Contact Hours/semester***	***Assessment Weightage and Marks***			
	Lecture	***45***		**CIE**	**SEE**	**Total**
	Tutorial	***-***	***Weightage, %***	***40***	***60***	***100***
	Practical	***30***	***Maximum Marks***	***40***	***60***	***100***
	Self-learning and Term work	***45***	***Minimum Marks***	***20***	***25***	***45****
	Total	***120***				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20+25 or 21+24)

Course Pre-Requisite: Engineering Physics, Engineering Chemistry, Engineering Mathematics-I & II and Environmental Fluid Mechanics-I

Course Objective: Students will be able to understand basic concepts of hydraulics as applied to fluid open channels, flow measurements, pipe hydraulics, pumps, and turbines for application to address Environmental Engineering problems of the society.

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Utilize the equations of design of open channel hydraulics to obtain economical geometric sections.	L3	1, 2, 3, 4, 6
CO2	Use of different fluid flow measuring devices.	L3	1, 2, 3, 4, 6
CO3	Use appropriate equations and principles to analyze pipe flow problems.	L3	1, 2, 3, 4, 6
CO4	Explain the different vanes due to the impact of jet	L3	1, 2, 3, 4, 6
CO5	Determine and analyze the performance aspects of fluid machinery specifically for pump	L3	1, 2, 3, 4, 6

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

Course Syllabus

Unit No.	Content	Lecture Hour
1	**Flow through Channels -** Closed and open channel flow, Geometric properties. Chezy's and Manning's equations. Hydraulic flow Characteristics for different cross sections, Derivations, and Numerical exercises. Specific energy curve and its applications, Minimum specific energy and Maximum discharge, Critical flow, Hydraulic jump in rectangular channels, Derivation with Froude number concept, Conjugate	**09**

	depth relationships -Numerical exercises. **Self-Learning and Term work** • **Geometric Properties -** Calculate hydraulic radius and depth • **Chezy/Manning-** Estimate flow velocity and discharge • **Channel Design -** Optimize cross-section for max discharge	
2	**Flow Measurements** - Orifices and Mouthpieces - Classification, Discharge Equations, Hydraulic Coefficients, Equations for coefficient of velocity -Numerical exercises. **Notches –** Types and Classification, Discharge equations, Types of Nappe, Numerical exercises, **Weirs** – Types, Discharge equations, Optical flow meters - Numerical exercises. **Self-Learning and Term work** • **Lab Simulations:** Try virtual labs for orifice and weir flow. • **Graphical Analysis:** Plot discharge vs. head for different devices. • **Real-world Applications:** Explore how these devices are used in dams, irrigation, and industrial systems.	**09**
3	**Flow through pipes -** Flow through pipes, Hydraulic and Energy gradients, Major and Minor losses in pipe flow, Head loss due to friction - Friction factor for commercial pipes, Head loss due to sudden expansion and contraction. Pipes in Series and Parallel, Equivalent pipe – Numerical exercises. **Water Hammer in Pipes -** Pressure rise due to the gradual and Sudden closure of valves in rigid and Elastic pipes, Control techniques – Types and functions, related Numerical exercises. **Self-Learning and Term work** • **Major and Minor losses :** Calculate head loss in a steel pipe using Darcy-Weisbach and Estimate loss due to a valve and bend • **Branch and Equivalent pipe:** Analyze flow distribution in a branched and equivalent system • **Concepts of Water Hammer:** Surge Tanks, Air Chambers Pressure Relief Valves	**09**
4	**Impact of Jets -** Introduction, the force exerted by the jet on plates - stationary vertical, inclined, and curved. In the direction of jet-moving flat vertical plate, inclined plate, and curved plate. Unsymmetrical moving curved plate when jet strikes tangentially at one end of the tip, a series of flat and curved vanes – Numerical exercises. **Self-Learning and Term work** • Calculate force on a vertical plate hit by a jet • Determine force components for a jet at 45°	**09**

	• Compute force for jet deflected by 120° • Real-world case studies: turbine blade erosion, jet cutting	
5	**Pumps -** Types of pumps, working principle, Characteristic curves, Priming, work done and efficiency, Cavitation in Centrifugal pumps, Submersible pumps, Multistage pumps, Sludge pumps, and Booster pumps. Numerical exercises. **Recent Trends -** Electronic Pressure Sensors, Solar pumps, Hydro pneumatic systems. Electronic sensors for water and Wastewater flow measurements. Application of AI and ML in Fluid Mechanics. **Self-Learning and Term work** • Calculate head, power, and efficiency • Compute total head and power for multiple stages • Estimate time required for priming a pump • Interpret Q-H curve for pump selection • Analyze flow rate and pressure for viscous fluid	**09**

Note: Components in SL and TW shall be assessed in CIE only.

Week	List of Experiments	Hours
1	Introduction	02
2	Calibration of Venturi meter	02
3	Calibration of Orifice meter	02
4	Calibration of Notches: Rectangular and Triangular notches	02
5	Determination of major losses in pipes	02
6	Determination of minor losses in pipes due to sudden expansion, sudden contraction, bends, and elbows.	02
7	Impact of jet on vanes (flat, inclined, and hemispherical).	02
8	Test on Centrifugal pumps: Single-stage centrifugal pumps.	02
9	Test on Centrifugal pumps: Multi-stage centrifugal pumps.	02
10	Hydraulic coefficients of Orifice plate	02
11	Hydraulic Coefficients of Mouthpiece	02
12	Flow through Channels	02
13	Flow through different media	02
14	Demonstration of turbines	02
15	CIE and laboratory test	02

Text Books

- Modi P. N. and Seth S. M., “Hydraulics and Fluid Mechanics”. Standard Book House, New Delhi. 2013.
- Subramanya K., “Fluid Mechanics and Hydraulic Machines - Problems and Solutions”, Tata Mc Graw Hill Publishing Co. Ltd. New Delhi. 2005.

Reference Books

- Bansal R. K., "Fluid Mechanics and Hydraulic Machines". Lakshmi Publications, New Delhi. 2011.
- Arora K. R., "Fluid Mechanics, Hydraulics and Hydraulic Machines". Standard Publishers Distributors, New Delhi. 2010.
- Som S. K. and Biswas G., "Introduction to Fluid Mechanics and Fluid Machines". Tata McGraw Hill, New Delhi. 2007.
- Technical articles from peer-reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis, and patented materials.

Journals/Magazines:

- Technical articles from peer-reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis, and patented materials.

Web/Digital resources:

- Fluid Mechanics virtual labs. http://eerc03-iiith.vlabs.ac.in/

SWAYAM/NPTEL:

- https://nptel.ac.in/courses/112105269
- https://archive.nptel.ac.in/courses/112/104/112104118/

Course Articulation:

COURSE OUTCOMES↓	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	-	-	-	-	-	-	3	3	3
CO2	3	3	3	3	1	-	-	-	-	-	-	3	3	3
CO3	3	3	3	3	-	-	-	-	-	-	-	3	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	3	3	3
CO5	3	3	3	3	-	-	-	-	-	-	-	3	3	3

High – 3, Medium – 2, Low – 1

<table>
<tr><td colspan="7">Department: Environmental Engineering</td></tr>
<tr><td colspan="3">Course Code: 24EV420</td><td colspan="4">Course Title: Hydrology and Water Resources Engineering</td></tr>
<tr><td colspan="2">Total Credits: 4
L-45: T-15: P-0: SL and TW-60</td><td>SDGs addressed: 6, 11, 12, 13 & 15</td><td colspan="2">Course Category: PCC</td><td colspan="2">Course Type: Theory</td></tr>
<tr><td rowspan="6">Teaching Learning Process</td><td></td><td>Total Contact Hours/semester</td><td colspan="4">Assessment Weightage and Marks</td></tr>
<tr><td>Lecture</td><td>45</td><td></td><td>CIE</td><td>SEE</td><td>Total</td></tr>
<tr><td>Tutorial</td><td>15</td><td>Weightage, %</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Practical</td><td>-</td><td>Maximum Marks</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Self-learning and Term work</td><td>60</td><td rowspan="2">Minimum Marks</td><td rowspan="2">20</td><td rowspan="2">25</td><td rowspan="2">45*</td></tr>
<tr><td>Total</td><td>120</td></tr>
</table>

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20+25 or 21+24)

Course Pre-Requisite: Basic knowledge of hydrology.

Course Objective: The course deals with the significance of the hydrologic cycle, global and Indian water resources, influencing natural processes, urban and groundwater hydrology, and modern tools for water resources management.

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Elucidate the hydrologic cycle and its importance in water resource management and the significance of precipitation data	L2	1, 2 & 3
CO2	Illustrate the influencing factors and methods of estimating evaporation, infiltration, and surface runoff.	L2	1, 2 & 3
CO3	Apply hydrograph theory in estimating overland runoff and analyze low flow conditions.	L3	4, 5 & 6
CO4	Identify suitable methods for measuring flow in streams and apply basic equations to estimate discharge from confined and unconfined aquifers.	L3	4, 6 & 7
CO5	Explain mechanisms for control of sedimentation in reservoirs and discuss applications of advanced technology including GIS in water resource management.	L3	6 & 7

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

Course Syllabus:

Unit No.	Content	Lecture Hours	Tutorial Hours
1	**Introduction -** Water resources and issues - Global, National, and Regional. Hydrologic cycle and significance. National water policy **Precipitation -** Forms and Types, Measurement. Estimation of average and Missing rainfall data, Mass curve, Hyetograph, Moving average curve, Intensity- duration-frequency curves; Precipitation indices-related Numerical exercises. **Self-Learning and Term work** • Review National Water Policy (2012, draft 2021) • Collect rainfall data from 3–4 nearby stations, calculate average rainfall using all three methods, and compare. • **Seminar/Presentation:** "Water issues in India – Global v/s National v/s Regional perspective."	**09**	**03**
2	**Evaporation -** Influencing factors, Measurement and Estimation- Numerical exercises, evaporation control measures. **Infiltration -** Influencing factors and Measurement, Infiltration indices – related numerical exercises. **Runoff:** Catchment, Influencing factors, Water budget equations, Rainfall-runoff relationship. Measures for attenuation of surface runoff. **Self-Learning and Term work** • **Field Activity:** Team installs a **Class A pan** (or simple water bowl) → monitor daily evaporation loss. • **Seminar/Role Play:** One team as "urban planners," another as "farmers," discussing runoff attenuation strategies. • Study case studies of **urban flooding** & role of infiltration in reducing it.	**09**	**03**
3	**Hydrographs:** Components – Types and Derivation; Base flow separation from total runoff - Numerical exercises **Hydrologic Routing:** Channel and Flood routing–concepts, Low flow analysis **Self-Learning and Term work** • Study **flood case studies** (e.g., 2018 Kerala floods) → analyze hydrograph behavior. • Work with IMD/**Grided rainfall data + CWC discharge data** to plot a hydrograph in Excel. • Teams argue for/against different **flood routing techniques**:	**09**	**04**
4	**Stream Gauging -** A- V method, Advanced techniques (Electromagnetic, ultrasonic, etc.). **Groundwater Hydrology -** Basic flow equations; Aquifers – Unconfined confined, Perched; Artificial recharge techniques. Causes of pollution/contamination of groundwater and Pollution prevention measures.	**09**	**03**

	Self-Learning and Term work • Watch demonstration videos on **current meters, floats, ADCP (Acoustic Doppler Current Profiler), ultrasonic & electromagnetic methods**. • Explore **case studies** on stream gauging in flood monitoring and irrigation planning. • Each group selects a **groundwater pollution issue in India** (e.g., Fluoride in Andhra Pradesh, Arsenic in Bengal, Nitrate pollution in Punjab, Industrial pollution in Gujarat).		
5	**Reservoir-**Types and Storage zones; measures to control reservoir sedimentation. **Recent trends -** Application of GIS and Remote sensing in water resource Management. **Self-Learning and Term work** • Understand how **satellite images** (e.g., LANDSAT, IRS) help in watershed management. • Read case studies on **GIS-based decision support systems (DSS)** for water allocation, drought monitoring, and reservoir operation. • Each team presents how storage zones are utilized and what challenges arise. **Introduction to Machine Learning in Hydrology:** Importance of ML in Groundwater Flow & Hydrological Modeling, Data Handling and Visualization for Hydrological Applications, Regression and classification models for hydrology.	**09**	**02**

Note: Components in SL and TW shall be assessed in CIE only.

Text Books

- Subramanya K. "Engineering Hydrology". 3rd Edition. Tata McGraw Hill Publishing Company Ltd., New Delhi. 2008.
- Todd D.K. "Groundwater Hydrology", Wiley Eastern Publication, New Delhi. 2004.

Reference Books

- Jayaram Reddy P. "A Text Book of Hydrology". Lakshmi Publications, New Delhi. 2005.
- Raghunath H.M. "Hydrology: Principles, Analysis, and Design". Revised 2nd Edition, New Age International (P) Ltd. 2006.
- Ven Te Chow. "Handbook of Applied Hydrology - A compendium of water Resources"
- Technology. Vol 1", McGraw Hill. 1964.
- Modi P.N., and Seth S.M. "Hydraulics and fluid mechanics". Standard Book House, New Delhi. 2013.

Journals/Magazines

- Technical articles from peer-reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis, and patented materials.

Web/Digital resources:

- Videos on YouTube
- Coursera
- http://www.cwc.gov.in/

- http://www.imd.gov.in/

SWAYAM/NPTEL:

- Surface Water hydrology, Prof. Rajib Maity, IIT Kharagpur https://nptel.ac.in/courses/105105214
- Water Resources Engineering, Prof. Rajesh Srivastava, Dr. Pranab K Mohapatra, IIT Kanpurhttps://nptel.ac.in/courses/105104103
- Hydrological Measurements and Analysis of Data, Dr. Sharad Kumar Jain, IIT Roorkee, https://nptel.ac.in/courses/105107129
- Advanced Hydrology, Dr. Subhankar Karmakar, IIT Bombay. https://nptel.ac.in/courses/105101002
- Advanced Hydrology, Dr. Ashu Jain, IIT Kanpur, https://nptel.ac.in/courses/105104029

Course Articulation:

COURSE OUTCOMES↓	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	1	2	1	1	3	-	1	2	3	3	2
CO2	3	3	2	2	-	1	2	1	1	3	2	3	3	2
CO3	3	3	1	2	2	1	2	-	2	2	1	2	2	2
CO4	3	3	-	3	-	-	2	2	1	1	3	3	2	2
CO5	3	3	1	-	1	1	3	-	2	-	2	3	3	3

High – 3, Medium – 2, Low – 1

<table>
<tr><td colspan="7">Department: Environmental Engineering</td></tr>
<tr><td colspan="3">Course Code: 24EV430</td><td colspan="4">Course Title: Survey Engineering</td></tr>
<tr><td colspan="2">Total Credits: 4
L-60: T-0: P-0: SL and TW-60</td><td colspan="2">SDGs addressed:
6, 8, 9, 11, 13, 15</td><td>Course Category: PCC</td><td colspan="2">Course Type: Theory</td></tr>
<tr><td rowspan="6">Teaching Learning Process</td><td></td><td colspan="2">Total Contact Hours/semester</td><td colspan="4">Assessment Weightage and Marks</td></tr>
<tr><td>Lecture</td><td colspan="2">60</td><td></td><td>CIE</td><td>SEE</td><td>Total</td></tr>
<tr><td>Tutorial</td><td colspan="2">-</td><td>Weightage, %</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Practical</td><td colspan="2">-</td><td>Maximum Marks</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Self-learning and Term work</td><td colspan="2">60</td><td rowspan="2">Minimum Marks</td><td rowspan="2">20</td><td rowspan="2">25</td><td rowspan="2">45*</td></tr>
<tr><td>Total</td><td colspan="2">120</td></tr>
</table>

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21+24)

Course Pre-Requisite: NIL

Course Objective: The students will obtain knowledge, understand, and apply surveying practices to execute Environmental Engineering infrastructure.

COURSE OUTCOMES (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Enlist the basic principles/concepts about types of survey techniques for application of Environmental Engineering structures.	L1	1, 2, 3, 4, 6, 7, 8 & 9
CO2	Record and analyze field measurements and solve numerical/field problems.	L2	1, 2, 3, 4, 6, 7, 8 & 9
CO3	Apply surveying concepts to water distribution networks, wastewater treatment facilities and other Environmental engineering applications.	L3	1, 2, 3, 4, 6, 7, 8 & 9
CO4	Summarize interpolations in contours for various applications using recent upgradations in survey instruments/equipment for environmental infrastructures.	L4	1, 2, 3, 4, 6, 7, 8 & 9
CO5	Apply survey engineering for application to remote sensing of – pollution hotspots, hazardous dumpsites, and geographical locations of hazardous vulnerability.	L3	1, 2, 3, 4, 5, 6, 7, 8 & 9

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Introduction** - Surveying, Classification, and Uses of Surveys. Units of Measurements, Maps, Survey of India topographical Maps and their numbering. Basic principles of surveying, Errors, Precision and accuracy, Reconnaissance survey. Applications in Environmental Engineering. **Measurement techniques:** Horizontal distance - Chains and tapes, Electromagnetic Distance Measurement devices, Ranging of lines, Direct and Indirect, Measurement of distances over sloping grounds, Chain and Tape corrections – Numerical exercises. **Self-Learning and Term work** • Lab component (Field work) • Numerical /analytical tasks • Group event	**12**
2	**Chain Surveying -** Accessories, Selection of stations and lines, Offsets and types, setting out of right angles, Working principle and use of optical square, prism square, cross-staff. Field book, conventional symbols, Obstacles in chain survey, Errors in chain survey and precautions, Numerical exercises. **Compass Surveying** - Meridians and bearings, Principle and use of Prismatic compass and Surveyor's compass, Dip, and Declination, Accessories required for compass surveying. Traverse - closed and open traverse, Computation of bearings and included angles, Local attraction, determination and corrections, Dependent and independent co-ordinates, Checks for closed traverse. - Numerical exercises. **Self-Learning and Term work** • Field work • Numerical /analytical tasks • Group event	**14**
3	**Levelling -** Principles and basic definitions, dumpy level types, adjustments and their types, Sensitiveness of bubble tube, Curvature, and refraction correction, Types of leveling. **Reduced Level -** Booking of levels, Rise and fall method and Height of instrument method, Comparison and arithmetic checks, Fly leveling, Errors and precautions. Introduction to Theodolites. **Self-Learning and Term work** • To get acquainted with instruments • Designing storm water management systems	**12**

4	**Contouring** - Contours-Types, characteristics, methods and uses, Interpolation techniques, Numerical exercises. **Self-Learning and Term work** • Mapping land use and vegetation • Numerical /analytical tasks • Group event	**10**
5	**Recent Trends** - Total station, LIDAR, Laser measurement instrument, GIS, GPS/ DGPS, aiding the design of water supply and sewerage projects, solid waste management facilities. Condition Assessment survey basic concept including inventories of existing systems. Applications of AI and ML in Survey Engineering. **Self-Learning and Term work** • Monitoring environmental changes and pollution • Planning waste management and treatment facilities	**12**

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

- Punmia B.C., Ashok Kumar Jain & Arun Kumar Jain "Surveying" Vol–1, Laxmi Publications, New Delhi, 2005.
- Duggal S.K., "Surveying" Vol- I, Tata McGraw Hill - Publishing Co. Ltd., New Delhi, 2004.

Reference Books:

- Milton O. Schmidt/Wong, "Fundamentals of Surveying" 3rd edition, Thomson- Learning.
- Roy S.K., "Fundamentals of Surveying" – Prentice-Han of India Private Limited.
- Alak De, "Plane Surveying", S. Chand & Co. Ltd., New Delhi, 2010.
- Chandra A.M., "Plane Surveying", New Age International (P) Ltd., New Delhi, 2002.
- Anderson J. and Mikhail E. "Introduction to Surveying", Mc-Graw Hill Book Company,1985.
- Banister A., "Surveying", Pearson Education, 2006.
- Kanetkar T. P. and Kulkarni S. V., "Surveying and Levelling", Part I, Pune Vidyarthi Griha Prakashan, 1988.
- Technical articles from peer-reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis, and patented materials.

Journals/Magazines:

- https://guides.libraries.psu.edu/c.php?g=378978&p=2568678
- https://ascelibrary.org/journal/jsued2
- https://ascelibrary.org/toc/jsued2/current

SWAYAM/NPTEL:

- https://onlinecourses.nptel.ac.in/noc23_ce05/preview
- https://onlinecourses.nptel.ac.in/noc23_hs67/preview

Course Articulation:

COURSE OUTCOMES↓	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	3	-	-	-	-	3	3	-	3
CO2	3	3	3	3	3	-	-	3	3	3	3	-	3	3
CO3	3	3	3	3	3	-	-	3	3	3	3	-	3	3
CO4	3	3	3	3	-	3	-	3	3	3	3	-	3	3
CO5	3	-	3	-	3	3	3	3	3	3	3	3	3	3

High – 3, Medium – 2, Low – 1

Department: Environmental Engineering						
Course Code: 24EV440		*Course Title: Geology and Geotechnical Engineering*				
Total Credits: 3 *L-45: T-0: P-0: SL and TW-45*		*SDGs addressed: 9, 11, 14, 15*	*Course Category: PCC*	*Course Type: Theory*		
Teaching Learning Process		*Total Contact Hours/semester*	*Assessment Weightage and Marks*			
	Lecture	*45*		**CIE**	**SEE**	**Total**
	Tutorial	*-*	*Weightage, %*	*40*	*60*	*100*
	Practical	*-*	*Maximum Marks*	*40*	*60*	*100*
	Self-learning and Term work	*45*	*Minimum Marks*	*20*	*25*	*45**
	Total	*90*				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21+24)

Course Pre-Requisite: Construction Engineering Materials and Engineering Chemistry

Course Objective: The student gains knowledge on fundamentals of geology, geological formations, engineering properties, and their importance and application in Environmental engineering. The course also substantiates the need for geotechnical engineering emphasizing types of soil its properties, environmental geo-techniques, and its application to Environmental Engineering.

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Explain the origin and types of rocks, classification, Weathering of rocks, cause–effects of earthquakes, soil erosion, landslides, and remedies.	L1	3, 6
CO2	Discuss concepts underlying structural geology, geotechnical engineering aspects, and soil properties.	L4	2, 3, 6
CO3	Describe soil classification systems, compaction, mineral mass balances; remineralization, and demineralization for water quality control.	L2	2, 3, 9
CO4	Explain and analyze permeability concepts through soils, and application of geo-synthetics in Environmental Engineering.	L2	5, 6, 8
CO5	Briefly summarize the characteristics of soil for waste discharge, pollution of soil and its remediation, role of various minerals and nutrients in the soil.	L4	5, 8, 9

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Introduction to Geology** - Origin of rocks, Classification - Igneous, Sedimentary and Metamorphic rocks. Weathering of rocks – Types. Geomorphology and Geodynamics - Soil erosion and Conservation. Landslides – Causes, remedies with gabions. **Self-Learning and Term work** • Rock cycle • Examples of different types of rocks • Exogenous and endogenous process	**06**
2	**Structural Geology** - Concepts of Outcrops, Dip and strike, Compass clinometers, Folds, Faults – Applications in Environmental Engineering. Physical Properties of Soil- Void ratio, porosity, and Percent voids. Degree of saturation, Moisture content, Specific gravity, Density (bulk, dry, saturated & submerged), and Inter-relationships. SBC of soil. Index properties of soils -Water content, Specific gravity, Relative density, Consistency limits and Indices, In-situ density (Lab component), and problem-solving. Particle size distribution (sieve analysis). Liquid-limit- Casagrande and Cone penetration methods, Plastic limit, and shrinkage limit determination. **Self-Learning and Term work** • Basic definitions of properties • Additional problem solving • Practical testing of consistency limits	**13**
3	**Classification of Soil** - Particle size classification. Field identification of soils (Field /Lab component). Clay mineralogy - Kaolinite, Illite, and Montmorillonite - Usefulness in Environmental Engineering applications. Dynamic of Soil - Methods of compaction. Geological minerals and water quality interlinkages. Remineralization and demineralization through geo - geo-filtration for water quality control. **Self-Learning and Term work** • Case study on clay mineral applications • Literature survey on role of minerals in water/wastewater treatment • Field identification of soils	**09**

4	**The flow of water through Soil:** Darcy's law - Assumptions and Validity, Coefficient of permeability and factors - Its determination (lab & field component), Permeability of stratified soils, Seepage velocity, Superficial velocity and Coefficient of percolation, Quicksand and Capillary phenomena. Geosynthetics – Geotextiles, Geogrids, Geomembranes, and Geocomposites, their applications in Environmental Engineering. (Lab component – Demo only). **Self-Learning and Term work** ● Case study on applications of geosynthetics ● Importance of permeability in different environmental applications ● Effects of soil pollution on permeability	**09**
5	**Recent Trends -** Soil characteristics for waste discharge, Soil acidity, Alkalinity, salinity and sodium, Soil remediation. Ecology of soil, Soil organic matter, Nitrogen and Sulphur economy of soils, Soil phosphorus, Potassium, Calcium, Magnesium, and Trace elements. Soil pollution – Sources, effects, and remedial measures. **Self-Learning and Term work** ● Case study on soil remediation ● Case studies on effects of soil pollution ● Role of soil in management of solid and liquid waste	**08**

Note: Components in SL and TW shall be assessed in CIE only.

Text Books

- Coduto D P, Yeung M R, and Kitch W A. "Geotechnical Engineering: Principles and Practices".2nd edition. PHI Learning Private Limited New Delhi. 2001.
- Maruthesha Reddy M T." A textbook of applied Engineering Geology". 2nd edition. New age International publishers. New Delhi. 2008.

Reference Books

- Robert L McConnell and Daniel C Abel. "Environmental Geology Today". Jones & Bartlett Learning LLC, USA. 2015.
- Shashi K Gulhati and Manoj Datta. "Geotechnical Engineering" (Civil Engineering series). Tata McGraw-Hill Education Private Limited. New Delhi. 2012.
- Ramamurthy T N and Sitharam T G." Geotechnical Engineering" (Soil mechanics). S Chand and Company Pvt. Ltd., New Delhi. 2013.
- Gopal Ranjan and Rao A. S. R. "Basic and applied soil mechanics". 2nd edition. New age International publishers. New Delhi. 2000.
- Varma C V J, Rao G V, Ramana G V and Rao A R G., "Waste containment with geosynthetics". CPHEEO, International Geosynthetics Society.
- Venkatappa Rao G and Suryanarayana Raju. "Engineering with Geosynthetics". Tata McGraw-Hill Education Private Limited. New Delhi. 1996.

Journals/Magazines:

- Technical articles from peer-reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis, and patented materials.

SWAYAM/NPTEL:

- Geotechnical Engineering – 1, By Prof. D. N. Singh, IIT Bombay
- Geotechnical Engineering II Foundation Engineering, By Prof. Dilip Kumar Baidya, IIT Kharagpur

Course Articulation:

COURSE OUTCOMES↓	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	3	3	-	-	-	3	3	-	-
CO2	3	3	-	-	-	3	-	-	-	-	-	3	-	3
CO3	3	3	-	-	-	3	3	-	3	-	3	3	3	3
CO4	3	-	2	-	-	3	3	2	3	-	3	3	3	3
CO5	3	-	2	-	-	3	3	2	3	-	3	3	3	3

High – 3, Medium – 2, Low – 1

Department: Environmental Engineering						
Course Code: 24EV451OE		***Course Title: Environmental Impact Assessment and Carrying Capacity***				
Total Credits: 3 ***L-45: T-0: P-0: SL and TW-45***		***SDGs addressed: 3, 6, 9, 11, 12, 13, 14, 15, 16, 17***	***Course Category: OEC***		***Course Type: Theory***	
Teaching Learning Process		***Total Contact Hours/semester***	***Assessment Weightage and Marks***			
	Lecture	***45***		**CIE**	**SEE**	**Total**
	Tutorial	***-***	***Weightage, %***	***40***	***60***	***100***
	Practical	***-***	***Maximum Marks***	***40***	***60***	***100***
	Self-learning and Term work	***45***	***Minimum Marks***	***20***	***25***	***45****
	Total	***90***				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21+24)

Course Pre-Requisite: Nil

Course Objective: The course provides knowledge on environmental impact assessment, tools, methods, and the importance of public participation and carrying capacity with the environment.

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Understand the concept and methodologies of EIA	L2	1, 2, 3 & 4
CO2	Understand the procedure for environmental clearance	L2	5, 6, 7 & 9
CO3	Discuss the basic information on environmental attributes like air, water soil, and noise	L3	4, 5, 6 & 7
CO4	Understand the concepts of the carrying capacity of the environment	L3	6, 7, 8 & 9
CO5	Relate the types of audits and carry out environmental audits for given Scenario	L4	7, 8 & 9

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Introduction and Methodology -** Definition, Concepts, Evolution, Types, Limitations, components of EIA process and content in EIA, settings – public participation, public hearing. Methodologies: background	**09**

	information, interaction matrix methodologies, network methodologies, etc., environmental setting- various factors, documentation, and selection process. **Self-Learning and Term work** • Read about **public participation and hearings** in EIA notification 2006. • Conduct a **mock public hearing** where some team members act as project proponents, others as community representatives, and others as regulatory officials. • Each team member presents **one limitation of EIA** and proposes solutions. Others discuss and critique.	
2	**Guidelines and Regulations** – Provisions in the EIA notification, Categorization of Industries for seeking environmental clearance from concerned authorities, procedure for environmental clearance, procedure for conducting environmental impact assessment report, Rapid and Comprehensive EIA, general structure of EIA document, Environmental management plan, post environmental monitoring. Role of National Green Tribunal in EIA, Environmental Management Plan (EMP), and Disaster Management Plan (DMP). **Self-Learning and Term work** • Step-by-step study of **application submission, TOR (Terms of Reference), public consultation, appraisal, and clearance**. • Study NGT's **role in monitoring, compliance, appeals, and judgments** related to EIA. • Team prepares a **mini-EIA report** for a hypothetical project (e.g., construction of a small dam or highway stretch). Each member drafts one section (baseline, impact, mitigation, EMP, DMP).	**09**
3	**Assessment of impact for air and noise environment:** Basic information of air quality, identification of type and quantity of air pollutant, existing air quality and air quality standards, impact assessment, mitigation. Basic information on noise, existing noise levels and standards, assessment of noise levels and impact, and mitigations. **Assessment of impact for water and soil environment:** Basic water quality information (Surface water and groundwater), water quality standards, identification of impact and its assessment, mitigations. Background information of soil environment, soil, and groundwater standards, Assessment of impact for groundwater and soil, mitigations. **Self-Learning and Term work** • Understand **impact assessment methods** (dispersion models, emission inventory).	**09**

	• Each team member selects one **environmental component** (Air / Noise / Water / Soil) and prepares a short report. • Team collects **real or secondary data** (air quality index, noise levels, water samples, soil parameters) from their city/region.	
4	**Carrying Capacity and the Environment:** Definition of Carrying capacity, Concept of carrying capacity, carrying capacity of the supporting ecosystem and assimilative carrying capacity, Fundamentals of assessment of carrying capacity – case studies. **Self-Learning and Term work** • Study **environmental, social, and economic carrying capacity**. • Study **ecosystem-based examples** (river basin capacity, coastal zone tourism capacity). • One argues **development projects can fit within carrying capacity with mitigation**.	**09**
5	**Post EIA activities -** EIA audit –Types and auditing procedure **EIA case studies** – Category A, B1 and B2 Applications of AI and ML in Environmental Impact Assessment **Self-Learning and Term work** • Learn the steps: planning → site visit → data collection → analysis → reporting → corrective actions. • Category A → handled at Central level (MoEF&CC), large-scale projects (e.g., power plants, mining, highways). • Prepare a short case study summary: project description, clearance process, key impacts, mitigation measures.	**09**

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

- Anjaneyulu Y., and Manickam V. "Environmental Impact Assessment Methodologies", 3rd Edition, B S Publications, 2020.
- Raman N. S, Gajbhiye A. R., and Khandeshwar S. R. "Environmental Impact Assessment".1st Edition, IK International Publications Pvt. Ltd. 2014.
- Jain R. K, Urban L. V, Stacey G. S. "Environmental Impact Analysis – A New Dimension in Decision Making", Van Nostrand Reinhold Co, 1977.

Reference Books:

- Anji Reddy and Mareddy, "Environmental Impact Assessment theory and practice" 1st Edition, B S Publications, 2019.
- Rau and Wooten, "Environmental Impact Assessment" Handbook, 1981.
- Indian Institute of Technology Guwahati 2011 Urban Carrying capacity: Concept and Calculation (Guwahati: Department of Civil Engineering)
- Environmental Impact Assessment, Canter R.L., Mc Graw Hill International Edition,1997.

- Glasson J., Therivel Riki, Chadwick Andrew, "Introduction to Environmental Impact Assessment", Oxford Brookes University 2012/ 4th edition.
- Clark Bisett B.C and Tomlinson P, "Perspective on Environmental Impact Assessment", Allied Publishers, 1985.
- Canter L, "Environmental Impact Assessment", McGraw Hill, 1995.
- EIA notifications and Publications, MoEF & CC, GoI
- Environmental Impact Analysis Handbook, John G. Rau and David C. Wooten (Ed), McGraw Hill Book.
- Environmental Efficiency and Carrying Capacity Indicators by Mathew May. LAP Lambert Academic Publishing (20 February 2013)
- Carrying Capacity based regional planning. IHS, Rotterdam. National Institute of Urban Affairs, New Delhi.

Journals/Magazines:

- Journals - Science Direct, acs.org.

Web/Digital resources:

- Teacher_manual_master_EIA.pdf (iitr.ac.in).
- IV-II-EIAM-UNIT-II.pdf (gpcet.ac.in).
- Sec_E_Topic_1.PDF (iaia.org).
- EIA Reader (ethernet.edu.et)

SWAYAM/NPTEL:

- Environmental Impact Assessment by Prof. Harshit Sosan Lakra, IIT Roorkee.

Course Articulation:

COURSE OUTCOMES↓	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	3	2	-	3	3	2	-	3	3	3	1	3
CO2	3	3	3	-	2	3	2	1	1	3	3	3	2	2
CO3	3	2	3	3	2	3	3	3	-	1	-	2	1	2
CO4	3	3	3	3	3	3	3	-	2	3	3	-	2	2
CO5	3	2	-	3	2	3	3	1	2	-	3	2	2	1

High – 3, Medium – 2, Low – 1

Department: Environmental Engineering						
Course Code: 24EV452OE		***Course Title: Climate Change and Impact on Global Economy***				
Total Credits: 3 L-45: T-0: P-0: SL and TW-45		***SDGs addressed: 7, 11, 13, 15***	***Course Category: OEC***		***Course Type: Theory***	
Teaching Learning Process		***Total Contact Hours/semester***	***Assessment Weightage and Marks***			
	Lecture	***45***		**CIE**	**SEE**	**Total**
	Tutorial	***-***	***Weightage, %***	***40***	***60***	***100***
	Practical	***-***	***Maximum Marks***	***40***	***60***	***100***
	Self-learning and Term work	***45***	***Minimum Marks***	***20***	***25***	***45****
	Total	***90***				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21+24)

Course Pre-Requisite: Environmental Studies

Course Objective: The course provides conceptual understanding of the drivers of climate change and its impacts on global climate, food-energy-environment nexus, and the need for sustainable development with mitigate measures integrated with cost-benefit analysis

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Explain key concepts of climate change and its anthropogenic drivers and occurrence of extreme events	L2	1, 3
CO2	Analyze the interlinks of weather, emissions, global warming and food security, inflation, poverty, and the need for sustainable development and carry out cost-benefit analysis for a given climate variability scenario	L3	2, 5
CO3	Discuss the technical possibilities for climate change reversal	L2	5, 7
CO4	Review the global-level policy options and implications	L2	1, 2
CO5	Interpret the trends in global emissions and understand the possible economic options to regulate climate change through carbon pricing	L3	3, 4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Global climate** – Global carbon emissions- past, present, future scenario, burden of climate change (Health & Economic), vulnerability and climate change. **Climatic variability and extreme weather events** - radiative forcing, cloud burst, heat wave, drought, floods, hurricanes, hydro-geological	**10**

	hazards, any other relevant episodes. **Self-learning and Term work** • Ocean acidification • Albedo effect • Tipping points and climate thresholds	
2	**Economic analysis of Global Climate Change-** Cost-benefit analysis of global climate change, global warming and climate damage function. Impact on growth and inflation, global production function, supply and demand effects. Market economy vulnerable to global warming for sectors- water, agriculture, coastal resources, energy, forestry, tourism and others Stern report and Nordhaus model, economic liability. **Self -learning and Term work** • Carbon cycle and Feedback loops • Climate models • Sustainable agriculture	**09**
3	**Low-carbon pathway for sustainable future –** Carbon Footprint and Scope 1, Scope 2, and Scope 3 emissions**,** Energy security and energy transition index, zero-emission coalitions, methods/technologies for reversing global heating, clean development mechanism (CDM) and applications, ecological footprint index. **Self-learning and Term work** • Biocapacity • Methane Hydrates and Permafrost • Carbon capture and storage	**09**
4	**Policy Responses to climate change**- Paris Agreement 2015, COP26, sustainable development goals (6, 7, 13) Proactive policy approaches – pollution prevention acts of different Countries. **Self-learning and Term work** • Climate Justice and Equity • Climate Sensity • Climate Refugees	**08**
5	**Climate change mitigation** **Economic policy options** - Carbon pricing emission trading, carbon taxes **Climate change adaptation strategies** (by sector) - water, agriculture, infrastructure, human health. Applications of AI and ML in prediction of Climate Change and Global Economy. **Self -learning and Term work** • Cost of climate Inaction • Climate change and Insurance markets • Agriculture subsidies and climate policy	**09**

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

- Rao P K (2015) "The Economics of Global Climate Change", Routledge, Taylor and Francis Group

Reference Books:

- Sincero. A. P and Sincero. G.A (1999), "Environmental Engineering – A Design Approach", Prentice Hall of India, New Delhi.
- Crawford M (1980), "Air pollution Control Theory", THM Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- Nevers N. D. (2000), "Air Pollution Control Engineering", International Edition. McGraw Hill International

Journals/Magazines:

- Refer to good research articles from Atmospheric Environment, Air Pollution Research, Science of total environment, etc.

Web/Digital resources:

- World Economic Forum, https://www.weforum.org/agenda/2021/06/impact-climate-change- global-GDP/
- Coursera: Economics and Policies of Climate Change, EDHEC
- WHO Global Air Quality Guidelines, https://www.who.int/news-room/questions-and-answers/item/who-global-air-quality-guidelines
- Guidelines for the Measurement of Ambient Air Pollutants

Swayam/NPTEL Course

- Climate Change : Impacts, Vulnerabilities and Adaptation in Developing Countries UNFCC 2007 https://unfccc.int/resource/docs/publications/impacts.pdf
- Advanced Financial Instruments for Sustainable Business and Decentralized Markets, By Prof. Abhinava Tripathi, IIT Kanpur. https://onlinecourses.nptel.ac.in/noc24_mg65/preview
- Masters in Climate Finance and Sustainability in Climate Finance and Sustainability, IIT Khanpur. https://emasters.iitk.ac.in/course/masters-in-climate-finance-and-sustainability

Course Articulation:

COURSE OUTCOMES↓	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	3	3	-	-	-	-	1	-	-
CO2	3	3	3	-	-	3	3	-	-	-	-	2	2	-
CO3	3	-	-	3	-	-	3	-	-	-	3	2	2	-
CO4	3	-	-	-	-	3	3	-	-	-	3	2	2	-
CO5	3	3	3	-	-	-	3	-	-	-	-	2	2	-

High – 3, Medium – 2, Low – 1

Department: Environmental Engineering						
Course Code: 24EV453OE		***Course Title:*** *Waste to Energy Technologies*				
Total Credits: 3 ***L-45: T-0: P-0: SL and TW-45***		***SDGs addressed:*** ***7, 8, 9, 11, 12, 13***	***Course Category:*** ***OEC***		***Course Type: Theory***	
Teaching Learning Process		***Total Contact Hours/semester***	***Assessment Weightage and Marks***			
	Lecture	***45***		**CIE**	**SEE**	**Total**
	Tutorial	***-***	***Weightage, %***	***40***	***60***	***100***
	Practical	***-***	***Maximum Marks***	***40***	***60***	***100***
	Self-learning and Term work	***45***	***Minimum Marks***	***20***	***25***	***45****
	Total	***90***				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21+24)

Course Pre-Requisite: Environmental Studies

Course Objective: The objective of the course is to provide insights into waste management options by reducing the waste destined for disposal and encouraging the use of waste as a resource for alternate energy production.

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Describe the 4R concept, sources and characterization of different wastes. Able to identify improper practices of solid waste disposal and their environmental implications. Understands the basic engineering principles of solid waste management.	L2	1, 3, 4, 5, 6, 7, 8 & 9,
CO2	Explain different waste to energy biochemical and thermos-chemical technologies based on their composition and characteristics.	L2	1, 3, 4, 5, 6, 7, 8 & 9
CO3	Explicate the recovery of byproducts during energy production from waste for effective management of environment.	L4	1, 3, 4, 5, 6, 7, 8 & 9
CO4	Summarize on in-house industrial waste to energy plants, Centralized and Decentralized Energy production, distribution and use.	L2	1, 3, 4, 5, 6, 7, 8 & 9
CO5	Discuss on global as well as Indian practices on energy recovery from waste with success and failures of the applications.	L4	1, 3, 4, 5, 6, 7, 8 & 9

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Introduction** Need of energy production from wastes, Principles of Waste Management and Waste Utilization. Current Energy scenario and energy from waste, Waste Management Hierarchy, and 5R concept. Waste as an Alternate Energy source. Wastes suitable for energy production. Waste Sources & Characterization, Waste production from different sectors. Classification of waste, domestic waste, industrial waste (hazardous and non-hazardous). Characterization of waste for energy utilization - Physical, Chemical, Proximate and ultimate analysis, Leaching properties. **Self-Learning and Term work** • Composition of waste • Challenges in waste management	**12**
2	**Technologies for Waste to Energy** Biochemical Conversion – Biomass energy, Energy production from organic waste through anaerobic digestion and fermentation, energy production from algae. Energy from fecal sludge. Microbial Fuel Cell. Thermo-chemical Conversion – Incineration and heat recovery, Pyrolysis, Gasification; syngas utilization, Plasma Arc Technology, and other newer technologies. **Self-Learning and Term work** • Cost aspects • Challenges faced • Case studies	**08**
3	**Waste to Energy Options** Landfill gas, collection, and recovery. Refuse Derived Fuel (RDF). Alternate Fuel Resource (AFR) – production and use in Cement plants, Thermal power plants, and Industrial boilers. Co-generation and Tri-generation concepts. Conversion of wastes to fuel resources for other useful energy applications. Energy from Plastic Wastes – Non-recyclable plastic wastes for energy recovery. **Self-Learning and Term work** • Environmental impacts and safety consideration • Collaborate with environmental engineers, waste management teams, and regulatory bodies to design and operate LFG recovery systems • Collaborate with municipal waste handlers to separate plastic waste streams. • Case studies	**09**

4	**Centralized and Decentralized Waste to Energy Plants** Location and Siting of 'Waste to Energy' plants. Industry Specific Applications – current-In-house use – agro-waste, pharmaceuticals, Pulp and paper, refinery and petrochemical industry, and any other industry. Centralized and Decentralized Energy production, distribution, and use. Waste to Energy & Environmental Implications, Environmental standards for Waste to Energy Plant operations and gas clean-up. **Self-Learning and Term work** • Work with GIS analysts, environmental scientists, and community representatives during site selection • Coordinate with IT and control system teams for smart grid integration and energy monitoring. • Study life cycle assessments (LCA) and carbon footprints of WTE plants • Work with emission control equipment suppliers and maintenance teams. • Study global emission standards (e.g., EU WTE Directive, CPCB norms in India) • Case studies	**09**
5	**Recent Trends** Ethical issues on converting waste to energy, Global Best Practices in Waste to energy production. Indian Scenario on Waste to Energy Production. Role of the Government and NGOs in promoting Waste to Energy. National energy management with specific implications in developing countries. Applications of AI and ML in conversion of waste to energy. **Self-Learning and Term work** • Emission standards and monitoring. • Public-private partnerships (PPP) models. • Collaborate with NGOs, Govt. bodies, CSR wings of companies, National energy planners • Case studies	**07**

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

- Marc Rogoff, Francois Screve, "Waste-to-Energy Technologies and Project Implementation", 2011, 2nd Edition, ISBN: 9781437778724
- Naomi B Klinghoffer, Marco J Castaldi, "Waste to Energy Conversion Technology", 2013, Woodhead Publishing ISBN: 9780857096364
- Management of Municipal Solid Waste, Ramachandra T. V. 2016, "Commonwealth of Learning", Canada, Centre for Ecological Sciences, Indian Institute of Science, India, Karnataka Environment Research Foundation, India, Published by Teri Press, New Delhi.

Reference Books:

- Industrial and Urban Waste Management in India, TERI Press.
- Advances in Waste-to-Energy Technologies, Rajeev Pratap Singh, Vishal Prasad, Barkha

Vaish, 2013, 1st Edition.

- Wealth from Waste: Trends and Technologies by Banwari Lal and Patwardhan, TERI Press.
- Fundamentals of waste and Environmental Engineering, S. N Mukhopadhyay, TERI Press.
- Gazette Notification on Waste Management Rules 2016.
- Report of the Task Force on Waste to Energy, Niti Ayog (Formerly Planning Commission) 2014.
- Municipal Solid Waste Management Manual, CPHEEO, 2016
- CPCB Guidelines for Co-processing in Cement/Power/Steel Industry

Journals/Magazines:

- Technical articles from peer-reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis, and patented materials.

Web/Digital resources:

- Waste to energy plant guidelines 2017 https://www.giz.de/en/downloads/GIZ_WasteToEnergy_Guidelines_2017.pdf https://www.energy.gov/sites/prod/files/2019/08/f66/BETO--Waste-to-Energy-Report-August-- 2019.pdf
- Waste to energy status in India - http://dr.ddn.upes.ac.in:8080/jspui/bitstream/123456789/1932/1/Waste%20to%20energy%20s tatus%20in%20India%20A%20short%20review_RSER.pdf
- Feasibility of Waste to Energy plants in India https://cdn.cseindia.org/docs/aad2019/swati-AAD.pdf

SWAYAM/NPTEL:

- Waste to Energy Conversion by Prof. P. Mondal, IIT Roorkee.

Course Articulation:

COURSE OUTCOMES↓	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	-	3	-	3	3	-	-	-	-	3	-	3
CO2	3	-	3	3	-	3	3	-	-	-	-	3	3	3
CO3	3	-	3	3	-	3	3	3	-	3	-	3	3	3
CO4	-	3	-	3	-	3	3	3	-	3	-	3	3	3
CO5	3	3	3	-	-	-	3	3	-	-	-	3	3	3

High – 3, Medium – 2, Low – 1

Department: Environmental Engineering						
Course Code: 24EV46L		***Course Title: Surveying Practices For Environmental Engineering Applications***				
Total Credits: 1.5 L-0: T-0: P-45		***SDGs addressed: 6, 11, 13, 14, 15***	***Course Category: PCCL***	***Course Type: Laboratory***		
Teaching Learning Process		***Total Contact Hours/semester***	***Assessment Weightage and Marks***			
	Lecture	***-***		**CIE**	**SEE**	**Total**
	Tutorial	***-***	***Weightage, %***	***40***	***60***	***100***
	Practical	***45***	***Maximum Marks***	***40***	***60***	***100***
	Self-learning and Term work	***-***	***Minimum Marks***	***20***	***25***	***45****
	Total	***45***				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21+24)

Course Pre-Requisite: Basic Mathematics

Course Objective: Surveying practice provides an opportunity for students to practically apply the theoretical aspects of engineering surveys using various survey instruments and accessories.

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Practice angular measurement by setting different geometrical sections using a chain, tape, and compass.	L3	1, 2, 3, 4, 7 & 9
CO2	Identify and use instruments for determining differences in elevation as well as the distance between two inaccessible points	L3	1, 2, 3, 4, 7 & 9
CO3	Draw profile and block levels using the leveling instrument and demo of Theodolite, Total Station, GPS	L2	1, 2, 3, 4, 7 & 9

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Syllabus:

Week	List of Experiments/ Programs	No. of Hours
1	Introduction and Familiarization with Survey Equipment's	3
2	To set out rectangles, pentagons, and hexagons, using tape/chain and Compass.	3

3	To measure the distance between two inaccessible points using a Chain/tape and compass.	3
4	To measure the distance between one accessible point and one inaccessible using a Chain/tape and compass.	3
5	To determine the difference in elevation between two points using fly Leveling technique	3
6	To determine the booking of levels using HI methods.	3
7	To determine the booking of levels using Rise & Fall methods	3
8	To conduct profile leveling for water supply/sewage/storm water drainage line and to draw the Longitudinal section for obtaining balancing depth of earthwork.	3
9	Theodolite (horizontal angle)	3
10	Theodolite Vertical angle	3
11	Total Station session – 1	3
12	Total Station session - 2	3
13	Total Station session – 3	3
14	Demo/Introduction – Drone Surveying	3
15	CIE	3

Text Books:

- Punmia B.C., "Surveying Vol.-1", Laxmi Publications, New Delhi.
- Kanetkar, T. P. and Kulkarni S. V. "Surveying and Leveling Part I", Pune Vidyarthi Griha Prakashan, 1988.

Reference Books:

- Punmia B.C., "Surveying Vol.-1", Laxmi Publications, New Delhi.
- Kanetkar, T.P. and Kulkarni, S.V. "Surveying and Leveling Part I", Pune Vidyarthi Griha Prakashan, 1988.
- Technical articles from peer-reviewed journals of Science Direct, acs.org, Springer, Taylor, and Francis, and patented materials

Course Articulation:

COURSE OUTCOMES↓	**PROGRAM OUTCOMES**											**PROGRAM SPECIFIC OUTCOMES**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	-	3	3	-	3	3	-	3	3	3
CO2	3	3	3	3	3	3	3	-	3	3	-	3	3	3
CO3	3	3	3	3	3	3	3	-	3	3	-	3	3	3

High – 3, Medium – 2, Low – 1

DEPARTMENT OF HUMANITIES
SCHEME & SYLLABUS
Third/Forth Semester
(From the Academic Year 2024-25)

<table>
<tr><td colspan="7">DEPARTMENT: Humanities</td></tr>
<tr><td colspan="3">Course Code: 24HU311/ 24HU411</td><td colspan="4">Course Title: Universal Human Values - II</td></tr>
<tr><td colspan="2">Total Credits: 02
L-30: T-0: P-0: SL and TW-30</td><td>SDGs addressed:
3,4,5,6,7,8,9,10,12,13</td><td colspan="2">Course Category:
HSMC</td><td colspan="2">Course Type: Theory</td></tr>
<tr><td rowspan="6">Teaching Learning Process</td><td></td><td>Total Contact Hours/semester</td><td colspan="4">Assessment Weightage and Marks</td></tr>
<tr><td>Lecture</td><td>30</td><td></td><td>CIE</td><td>SEE</td><td>Total</td></tr>
<tr><td>Tutorial</td><td>-</td><td>Weightage, %</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Practical</td><td>-</td><td>MaximumMarks</td><td>20</td><td>30</td><td>50</td></tr>
<tr><td>Self-learning and Term work</td><td>30</td><td rowspan="2">MinimumMarks</td><td rowspan="2">10</td><td rowspan="2">13</td><td rowspan="2">23*</td></tr>
<tr><td>Total</td><td>60</td></tr>
</table>

Note: *For passing the student must score a Minimum of 23 Marks (CIE+SEE: 10+13 or 11+12)

COURSE PRE-REQUISITE: Students Induction Program (desirable).

COURSE OBJECTIVES:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Understand self (I) clearly through self-exploration and demonstrate natural acceptance in situations by right understanding.	L2	WK1, WK3
CO2	Distinguish between self (I) body, and co-existence of both to be in harmony.	L2	WK2, WK6
CO3	Relate to family and society by understanding nine universal human values in human- human relationship for harmony and prosperity.	L2	WK1, WK4
CO4	Explain interconnectedness and mutual fulfilment at all four orders of nature for co- existence.	L2	WK7, WK8
CO5	Develop commitment for holistic understanding of harmony by natural acceptance of human values in his/her profession and society.	L2	WK5, WK8

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Introduction - Need, Basic Guidelines, Content and Process for Value Education** 1. Purpose and motivation for the course, recapitulation from Universal Human Values-I. 2. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration. 3. Continuous Happiness and Prosperity- A look at basic Human Aspirations. 4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority. 5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario. 6. Method to fulfill the above human aspirations: understanding and living in harmony at various levels. **Self-Learning and Term work** • Identify one personal decision influenced by natural acceptance and note its effect on your choice. • Identify a campus or community issue and propose a simple solution based on harmony principles.	**06**
2	**Understanding Harmony in the Human Being - Harmony in Myself!** 7. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. 8. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility. 9. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer). 10. Understanding the characteristics and activities of 'I' and harmony in 'I'. 11. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail. 12. Programs to ensure Sanyam and Health. **Self-Learning and Term work** • Reflect on your daily routine and identify 2–3 habits that promote harmony between your mind ('I') and body, noting their impact on well-being. • Design a simple weekly wellness plan (eg. exercises-self and body, food- self and body).	**06**
3	**Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship** 13. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its	**06**

	fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship. 14. Understanding the meaning of Trust; Difference between intention and competence 15. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship. 16. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals 17. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family. **Self-Learning and Term work** • Reflect on a recent interaction with peers or family and identify how trust, respect, or other universal values influenced the outcome. • Prepare a flowchart or concept map showing how values in family can scale to society and the wider world.	
4	**Understanding Harmony in the Nature and Existence - Whole existence as Coexistence** 18. Understanding the harmony in the Nature. 19. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature. 20. Understanding Existence as Co-existence of mutually interacting units in all pervasive space. 21. Holistic perception of harmony at all levels of existence. **Self-Learning and Term work** • Observe one aspect of your daily life (water, energy, waste, plants, or animals) and note how your actions impact other orders of nature. • create a diagram or model showing the interdependence of human, animal, plant, and material orders, and discuss ways to maintain balance.	**06**
5	**Implications of the above Holistic Understanding of Harmony on Professional Ethics** 22. Natural acceptance of human values. 23. Definitiveness of Ethical Human Conduct. 24. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. 25. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. 26. Case studies of typical holistic technologies, management models and production systems. 27. Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations.	**06**

	28. Sum up. **Self-Learning and Term work** • Reflect on a recent project or assignment and identify one way your technical or professional skills could contribute to eco-friendly or people-friendly solutions. • Identify one campus or community process (e.g., energy use, waste management) and propose a simple, value-based strategy to improve sustainability and social responsibility.	

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

- Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010.

References

- Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
- Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
- The Story of Stuff (Book).
- The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
- Small is Beautiful - E. F Schumacher.
- Slow is Beautiful - Cecile Andrews
- Economy of Permanence - J C Kumarappa
- Bharat Mein Angreji Raj – Pandit Sunderlal
- Rediscovering India - by Dharampal
- Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
- India Wins Freedom - Maulana Abdul Kalam Azad
- Vivekananda - Romain Rolland (English)
- Gandhi - Romain Rolland (English)

Web-links:

- https://onlineethics.org/

Course Articulation Matrix:

COURSE OUTCOMES	PROGRAM OUTCOMES										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	-	-	-	-	1	2	2	-	-	-
CO2	-	-	-	-	-	1	1	1	-	-	-
CO3	-	-	-	-	-	2	2	2	-	-	-
CO4	-	-	-	-	-	2	2	2	-	-	-
CO5	-	-	-	-	-	2	2	2	-	-	-

High – 3, Medium – 2, Low – 1