

IV & V SEMESTER CURRICULUM & SYLLABI

Applicable to the students admitted to
DEPARTMENT OF SCIENCE AND HUMANITIES

2021: CBCS

Academic year 2022-2023

onwards



VEL TECH HIGH TECH

Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

An Autonomous Institution

#60, Avadi – Vel Tech Road, Vel Nagar,
Avadi, Tamil Nadu 600062



VEL TECH HIGH TECH

Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

An Autonomous Institution

Approved by AICTE-New Delhi, Affiliated to Anna University, Chennai

Accredited by NBA, New Delhi & Accredited by NAAC with "A" Grade & CGPA of 3.27

DEPARTMENT OF SCIENCE AND HUMANITIES

S. No.	NAME OF THE COURSE	DEPARTMENT	SEMESTER
1	Statistics for Data Science	AI&DS	IV
2	Probability and Queuing Theory	CSE & IT	IV
4	Numerical Methods	Civil & Chemical	IV
		CSE & IT	V
5	Probability and Random Process	ECE	IV
6	Statistics and Numerical Methods	Mechanical	IV
7	Environmental Science and Engineering	Chemical	IV
8	Environmental Sciences	AI&DS, Biotech, Civil, ECE, IT, and Mech	IV (Approved in 1 st BOS Meeting)
9	Foreign Language French	All Branches	V
10	Fundamentals of Photovoltaic and its Applications	All Branches	V
11	Recent Trends in Batteries	All Branches	V
12	Green Chemistry	All Branches	VI

LIST OF OPEN ELECTIVE COURSES

S. No	COURSE CODE	NAME OF THE COURSE
1	21EN01OT	Foreign Language – French
2	21PH02OT	Fundamentals of Photovoltaic and its Applications
3	21CY03OT	Recent Trends in Batteries
4	21CY04OT	Green Chemistry



VEL TECH HIGH TECH

Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

An Autonomous Institution

Approved by AICTE-New Delhi, Affiliated to Anna University, Chennai

Accredited by NBA, New Delhi & Accredited by NAAC with "A" Grade & CGPA of 3.27

Course code	21MA43T	Semester	IV				
Category	BASIC SCIENCE COURSE (BSC)			L	T	P	C
Course Title	STATISTICS FOR DATA SCIENCE (for AI&DS Only)			3	1	0	4

COURSE OBJECTIVES:

- This course aims at providing the required skill to apply the statistical tools in engineering Problems.
- To introduce the basic concepts of probability and two-dimensional random variables.
- To acquaint the knowledge of testing of hypothesis and for small and large samples.

PREREQUISITE:

- Basic concepts in probability and statistics.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C403.1	<i>Solve</i> problems using the concepts of Probability, random variables and standard discrete and continuous distributions	K3
C403.2	<i>Compute</i> the probabilities of two-dimensional random variables and use the central limits theorem to find the probability of the sum of independent and identically distributed random variables.	K3
C403.3	<i>Apply</i> the concept of testing of hypothesis for small and large samples in real life problems.	K3
C403.4	<i>Apply</i> the basic concepts of classification of designs of experiments in the field of agriculture and statistical quality control.	K3
C403.5	<i>Imparted</i> the notion of sampling distributions and statistical technique used in engineering and management problems.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
C403.1	2	1	1	-	-	-	-	-	-	-	-	-	3	3
C403.2	2	1	1	-	-	-	-	-	-	-	-	-	2	2
C403.3	2	1	1	-	-	-	-	-	-	-	-	-	2	2
C403.4	2	1	1	-	-	-	-	-	-	-	-	-	2	2
C403.5	2	1	1	-	-	-	-	-	-	-	-	-	2	2

Note: 1: Slight, 2: Moderate, 3: Substantial

UNIT I PROBABILITY AND RANDOM VARIABLES 9+3

Probability – The axioms of probability – Conditional probability – Baye’s theorem - Discrete and continuous random variables –Moments- Moment generating functions -Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

UNIT II TWO - DIMENSIONAL RANDOM VARIABLES 9+3

Joint distributions – Marginal and conditional distributions – Covariance-Multinomial Distribution- Bivariate normal distribution-Central limit theorem (for independent and identically distributed random variables) Correlation and linear regression.

UNIT III TESTING OF HYPOTHESIS 9+3

Sampling distributions – Estimation of Parameters – Statistical hypothesis – Large sample test based on Normal distribution for single mean and difference of means – Tests based on t, Chi-square and F distributions for mean, variance and proportion – Contingency table (test for independence)- Goodness of fit.

UNIT IV DESIGN OF EXPERIMENTS 9+3

One way and Two-way classification – Completely randomized design- Randomized block design – Latin square design – 2^2 factorial designs.

UNIT V STATISTICAL QUALITY CONTROL 9+3

Control charts for measurements (X and R charts) - Control charts for attributes (p, c and np charts) - Tolerance limits – Acceptance sampling.

Total: 60 Periods**LEARNING RESOURCES:****TEXT BOOKS:**

1. Johnson, R.A., Miller, I and Freund J., "Miller and Freund’s Probability and Statistics for Engineers", Pearson Education, Asia, 2018.
2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.

REFERENCES:

1. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
2. Papoulis, A. and Unnikrishnapillai, S., "Probability, Random Variables and Stochastic Processes", McGraw Hill Education India, 4th Edition, New Delhi, 2010.
3. James D. Miller., “Statistics for Data Science”, Published by Packt Publishing Ltd., First published, November 2017.



VEL TECH HIGH TECH

Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

An Autonomous Institution

Approved by AICTE-New Delhi, Affiliated to Anna University, Chennai

Accredited by NBA, New Delhi & Accredited by NAAC with "A" Grade & CGPA of 3.27

Course code	21MA41T	Semester	IV			
Category	BASIC SCIENCE COURSE (BSC)		L	T	P	C
Course Title	PROBABILITY AND QUEUING THEORY (Common to CSE and IT)		3	1	0	4

COURSE OBJECTIVES:

- To understand one and two- dimensional random variables and to introduce some Standard distributions.
- To discuss the basic concepts of random processes which are widely used in CSE& IT Fields.
- To understand the concept of queuing models and apply in engineering.
- To identify and interpret the significance of advanced queuing models.

PREREQUISITE:

- Basic concepts in probability.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C401.1	<i>Understand</i> the fundamental knowledge of the concepts of probability and standard distributions.	K2
C401.2	<i>Comprehend</i> the basic concepts of one and two dimensional random variables and apply in engineering applications.	K2
C401.3	<i>Understand</i> various classifications of random processes.	K2
C401.4	<i>Analyse</i> different queuing models and its applications.	K4
C401.5	<i>Apply</i> Non-Markovian queuing models and Network.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
C401.1	2	1	1	-	-	-	-	-	-	-	-	-	3	3
C401.2	2	1	1	-	-	-	-	-	-	-	-	-	2	2
C401.3	2	1	1	-	-	-	-	-	-	-	-	-	2	2
C401.4	2	1	1	-	-	-	-	-	-	-	-	-	2	2
C401.5	2	1	1	-	-	-	-	-	-	-	-	-	2	2

Note: 1: Slight, 2: Moderate, 3: Substantial

UNIT I RANDOM VARIABLES AND DISTRIBUTIONS**9+3**

Discrete and continuous random variables- Distribution function of random variable – Properties – Probability mass function – Probability density function – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

UNIT II TWO - DIMENSIONAL RANDOM VARIABLES**9+3**

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables.

UNIT III RANDAM PROCESSES AND MARKOV CHAINS**9+3**

Classification – Stationary process – Markov process - Poisson process – Discrete parameter Markov chain – Transition probabilities.

UNIT IV QUEUEING MODELS**9+3**

Markovian queues – Birth and death Queuing models – Single and multiple server queueing models – Little's formula - Queues with finite waiting rooms.

UNIT V NON-MARKOVIAN QUEUES AND QUEUE NETWORKS**9+3**

M/G/1 queue – PollaczekKhinchin formula –M / D/ 1 - Series queues – Open and closed Jackson networks.

Total: 60 Periods**LEARNING RESOURCES:****TEXT BOOKS:**

1. Gross. D. and Harris. C.M., "Fundamentals of Queueing Theory", Wiley Student edition, 2013.
2. Ibe, O.C., —Fundamentals of Applied Probability and Random Processes", Elsevier, 1st Indian Reprint, 2014.

REFERENCES:

1. Hwei Hsu, "Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes", Tata McGraw Hill Edition, New Delhi, 2014.
2. Taha, H.A., "Operations Research", 9th Edition, Pearson India Education Services, Delhi, 2017.
3. Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications", John Wiley and Sons, 2017.
4. Yates, R.D. and Goodman. D. J., "Probability and Stochastic Processes", 2nd Edition, Wiley India Pvt. Ltd. 2012.



VEL TECH HIGH TECH

Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

An Autonomous Institution

Approved by AICTE-New Delhi, Affiliated to Anna University, Chennai

Accredited by NBA, New Delhi & Accredited by NAAC with "A" Grade & CGPA of 3.27

Course code	21MA44T	Semester	IV				
Category	BASIC SCIENCE COURSE (BSC)			L	T	P	C
Course Title	NUMERICAL METHODS (Common to Chemical and Civil)			3	1	0	4

COURSE OBJECTIVES:

- To provide the necessary basic concepts of a few numerical methods.
- To provide procedures for solving numerically different kinds of problems occurring in the field of Engineering and Technology.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

PREREQUISITE:

- Basic knowledge of ordinary differential equations.
- Multivariable calculus.

COURSE OUTCOME:

CO No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C404.1	<i>Solve</i> algebraic equations that arise during the study of Engineering problems	K3
C404.2	<i>Use</i> various interpolation techniques for solving problems in Engineering.	K3
C404.3	<i>Apply</i> the numerical techniques of differentiation and integration for engineering problems.	K3
C404.4	<i>Solve</i> initial value problems numerically that arise in Science and Engineering.	K3
C404.5	<i>Solve</i> boundary value problems that encounter in different fields of Engineering study	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
C404.1	2	1	1	1	-	-	-	-	-	-	-	-	-	-
C404.2	2	1	-	1	-	-	-	-	-	-	-	-	-	-
C404.3	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C404.4	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C404.5	2	1	-	-	-	-	-	-	-	-	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

UNIT I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS**9+3**

Solution of algebraic and transcendental equations – Fixed point iteration method – Newton Raphson method – Solution of linear system of equations – Gauss elimination method – Pivoting – Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel – Eigen values of a matrix by Power method and Jacobi's method for symmetric matrices.

UNIT II INTERPOLATION AND APPROXIMATION**9+3**

Interpolation with unequal intervals – Lagrange's interpolation – Inverse interpolation using Lagrange's method-Newton's divided difference interpolation –Interpolation with equal intervals – Newton's forward and backward difference formulae.

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION**9+3**

Approximation of derivatives using interpolation polynomials – Numerical integration using Trapezoidal, Simpson's 1/3 rule and Simpson's 3/8 rule– Romberg's Method – Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules.

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS**9+3**

Taylor's series method - Picard's - Euler's method - Modified Euler's method -Runge - Kutta method - Milne's and Adams-Bashforth predictor corrector methods for solving first order equations.

UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS**9+3**

Finite difference methods for solving second order two – point linear boundary value problems – Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation – Bender - Schmidt recurrence relation - Crank - Nicolson method – One dimensional wave equation by explicit method.

Total: 60 Periods**LEARNING RESOURCES:****TEXT BOOKS:**

1. Numerical methods with C++ programming by Nita H. Shah, PHI. 2009.
2. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
3. Burden, R.L. and Faires, J.D., "Numerical Analysis", 9th Edition, Cengage Learning, 2016.

REFERENCES:

1. Numerical methods for engineers and scientists by Joe D. Hoffman. Marcel Dekker, Inc. 2001.
2. Numerical methods with programs in C by T. Veerarajan and T. Ramachandran. Tata McGraw-Hill. 2006.
3. Sankara Rao, K., "Numerical Methods for Scientists and Engineers", Prentice Hall of India Pvt. Ltd, 3rd Edition, New Delhi, 2007.
4. Sastry, S.S., "Introductory Methods of Numerical Analysis", PHI Learning Pvt. Ltd, 5th Edition, 2015



VEL TECH HIGH TECH

Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

An Autonomous Institution

Approved by AICTE-New Delhi, Affiliated to Anna University, Chennai

Accredited by NBA, New Delhi & Accredited by NAAC with "A" Grade & CGPA of 3.27

Course code	21MA42T	Semester	IV				
Category	BASIC SCIENCE COURSE (BSC)			L	T	P	C
Course Title	PROBABILITY AND RANDOM PROCESSES (For ECE Only)			3	1	0	4

COURSE OBJECTIVES:

- To provide necessary basic concepts in probability and random processes.
- To understand the basic concepts of random processes and spectral densities.
- To understand the significance of linear systems with random inputs.

PREREQUISITE:

- Basic concepts in probability

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C402.1	<i>Understand</i> the fundamental knowledge of the concepts of probability.	K2
C402.2	<i>Understand</i> the basic concepts of one and two dimensional random variables and apply in engineering applications.	K2
C402.3	<i>Apply</i> the concept random processes in engineering disciplines.	K3
C402.4	<i>Understand</i> and apply the concept of correlation and spectral densities.	K3
C402.5	Able to <i>analyze</i> the response of random inputs to linear time invariant systems.	K4

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
C402.1	2	1	1	-	-	-	-	-	-	-	-	-	3	3
C402.2	2	1	1	-	-	-	-	-	-	-	-	-	2	2
C402.3	2	1	1	-	-	-	-	-	-	-	-	-	2	2
C402.4	2	1	1	-	-	-	-	-	-	-	-	-	2	2
C402.5	2	1	1	-	-	-	-	-	-	-	-	-	2	2

Note: 1: Slight, 2: Moderate, 3: Substantial

UNIT I PROBABILITY AND RANDOM VARIABLES 9+3

Discrete and continuous random variables- Distribution function of random variable – Properties – Probability mass function – Probability density function – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

UNIT II TWO - DIMENSIONAL RANDOM VARIABLES 9+3

Joint Distributions – Marginal and conditional distributions – covariance – correlation and linear regression – transformation of random variables.

UNIT III RANDOM PROCESSES 9+3

Classification of random process– stationary process – Markov process - Markov chain - Poisson process – properties – random telegraph process.

UNIT IV CORRELATION AND SPECTRAL DENSITIES 9+3

Auto correlation functions – cross correlation functions – properties – power spectral density – cross spectral density – properties.

UNIT V LINEAR SYSTEMS WITH RANDOM INPUTS 9+3

Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and cross correlation functions of input and output.

Total: 60 Periods

LEARNING RESOURCES:**TEXT BOOKS:**

1. Ibe, O.C.," Fundamentals of Applied Probability and Random Processes ", 1st Indian Reprint, Elsevier, 2014.
2. Peebles, P.Z., Bertram Emil Shi "Probability, Random Variables and Random Signal Principles ", Tata McGraw Hill, 2015.

REFERENCES:

1. Cooper. G.R., McGillem. C.D., "Probabilistic Methods of Signal and System Analysis", Oxford University Press, New Delhi, 3rd Indian Edition, 2012.
2. G.Balaji, "Probability and Random Process", Balaji Publication, 7th Edition 2020.
3. T. Veerarajan, "Probability and Statistics, Random Process and Queuing Theory", McGraw Hill Education, 1st Edition, 2018.
4. P. Sivaramakrishna Das, "Probability and Random Process", Pearson Education, 6th Edition, 2019.
5. P.Kandasamy, Thilagavathi. K and Gunavathi.K., "Probability Random variable and Random Process", S.Chand&Co. Pvt. Ltd, 2nd Edition, 2015.
6. Yates. R.D. and Goodman. D.J., —Probability and Stochastic Processes", Wiley India Pvt. Ltd., Bangalore, 3rd Edition 2014.



VEL TECH HIGH TECH

Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

An Autonomous Institution

Approved by AICTE-New Delhi, Affiliated to Anna University, Chennai

Accredited by NBA, New Delhi & Accredited by NAAC with "A" Grade & CGPA of 3.27

Course code	21MA45T	Semester	IV			
Category	BASIC SCIENCE COURSE (BSC)		L	T	P	C
Course Title	STATISTICS AND NUMERICAL METHODS (For Mechanical only)		3	1	0	4

COURSE OBJECTIVES:

- To provide the necessary basic concepts of a few statistical methods.
- To understand and implement various concepts of numerical analysis.
- To identify the areas applied in numerical interpolation, differential equations and method of finding solutions.

PREREQUISITE:

- Ordinary differential equations
- Multivariable calculus

COURSE OUTCOME:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C405.1	<i>Analyze</i> the different samples of data at different level of significance using various hypothesis testing.	K2
C405.2	<i>Design</i> experiments using suitable ANOVA techniques and draw conclusions.	K2
C405.3	<i>Learn</i> how to obtain numerical solution of nonlinear equations using bisection, Newton – Raphson and fixed-point iteration methods.	K3
C405.4	<i>Use</i> interpolation methods to solve problems.	K3
C405.5	<i>Apply</i> the numerical techniques for solutions of ordinary differential equations	K4

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
C405.1	2	1	1	1	-	-	-	-	-	-	-	-	-	-
C405.2	2	1	-	1	-	-	-	-	-	-	-	-	-	-
C405.3	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C405.4	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C405.5	2	1	-	-	-	-	-	-	-	-	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

UNIT I TESTING OF HYPOTHESIS 9+3

Large sample test based on Normal distribution for single mean and difference of means – Tests based t, Chi-square and F distributions for testing means and variances – Contingency table (Test for Independency) – Goodness of fit.

UNIT II DESIGN OF EXPERIMENTS 9+3

One way and Two way classifications - Completely randomized design – Randomized block design –Latin square design – 2^2 factorial design.

UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9+3

Newton Raphson method – Gauss elimination method – pivoting – Gauss Jordan methods – Crout’s method – Iterative methods of Gauss Jacobi and Gauss Seidel – Matrix inversion by Gauss Jordan method – Eigen values of a matrix by power method, Jacobi method.

UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION 9+3

Lagrange’s and Newton’s divided difference interpolations – Newton’s forward and backward difference interpolation – numerical integration, Newton-Cotes formulae- Numerical single and double integrations using Trapezoidal and Simpson’s 1/3 rules.

UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATION**9+3**

Taylor’s series method – Euler’s method – Modified Euler’s method – Heun’s method - Fourth order Runge-Kutta method for solving first order equations – Milne’s predictor corrector methods for solving first order equations.

Total: 60 Periods**LEARNING RESOURCES:****TEXT BOOKS:**

1. Steven C Chapra and Raymond P Canale, Numerical Methods for Engineers, McGraw Hill Education, New Delhi, 2012.
2. Manish Goyal, “Statistics and Numerical methods” , Lakshmi Publications, 2016.

REFERENCES:

1. Johnson R.A., and Gupta. C.B., "Miller and Freund’s Probability and Statistics for Engineers", 11th Edition, Pearson Education, , Asia, 2011.
2. Walpole R.E., Myers. R.H., Myers. S.L., and Ye. K., "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson Education, Asia, 2011.
3. Jain, M. K., Iyengar, S. R. K. and Jain, R. K., Numerical Methods for Scientific and Engineering Computation, New Age International Publishers (2008).
4. Grewal. B. S., "Numerical Methods in Science and Engineering", 40th Edition, Khanna Publishers, 2007.



VEL TECH HIGH TECH

Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

An Autonomous Institution

Approved by AICTE-New Delhi, Affiliated to Anna University, Chennai

Accredited by NBA, New Delhi & Accredited by NAAC with "A" Grade & CGPA of 3.27

Course code	21MA44T	Semester	V				
Category	BASIC SCIENCE COURSE (BSC)			L	T	P	C
Course Title	NUMERICAL METHODS (Common to CSE and IT)			3	1	0	4

COURSE OBJECTIVES:

- To provide the necessary basic concepts of a few numerical methods.
- To provide procedures for solving numerically different kinds of problems occurring in the field of Engineering and Technology.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

PREREQUISITE:

- Basic knowledge of ordinary differential equations.
- Multivariable calculus.

COURSE OUTCOME:

CO No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C404.1	<i>Solve</i> algebraic equations that arise during the study of Engineering problems	K3
C404.2	<i>Use</i> various interpolation techniques for solving problems in Engineering.	K3
C404.3	<i>Apply</i> the numerical techniques of differentiation and integration for engineering problems.	K3
C404.4	<i>Solve</i> initial value problems numerically that arise in Science and Engineering.	K3
C404.5	<i>Solve</i> boundary value problems that encounter in different fields of Engineering study	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
C404.1	2	1	1	1	-	-	-	-	-	-	-	-	-	-
C404.2	2	1	-	1	-	-	-	-	-	-	-	-	-	-
C404.3	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C404.4	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C404.5	2	1	-	-	-	-	-	-	-	-	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

UNIT I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS**9+3**

Solution of algebraic and transcendental equations – Fixed point iteration method – Newton Raphson method – Solution of linear system of equations – Gauss elimination method – Pivoting – Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel – Eigen values of a matrix by Power method and Jacobi's method for symmetric matrices.

UNIT II INTERPOLATION AND APPROXIMATION**9+3**

Interpolation with unequal intervals – Lagrange's interpolation – Inverse interpolation using Lagrange's method-Newton's divided difference interpolation –Interpolation with equal intervals – Newton's forward and backward difference formulae.

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION**9+3**

Approximation of derivatives using interpolation polynomials – Numerical integration using Trapezoidal, Simpson's 1/3 rule and Simpson's 3/8 rule– Romberg's Method – Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules.

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS**9+3**

Taylor's series method - Picard's - Euler's method - Modified Euler's method -Runge - Kutta method - Milne's and Adams-Bashforth predictor corrector methods for solving first order equations.

UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS**9+3**

Finite difference methods for solving second order two – point linear boundary value problems – Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation – Bender - Schmidt recurrence relation - Crank - Nicolson method – One dimensional wave equation by explicit method.

Total: 60 Periods**LEARNING RESOURCES:****TEXT BOOKS:**

1. Numerical methods with C++ programming by Nita H. Shah, PHI. 2009.
2. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
3. Burden, R.L. and Faires, J.D., "Numerical Analysis", 9th Edition, Cengage Learning, 2016.

REFERENCES:

1. Numerical methods for engineers and scientists by Joe D. Hoffman. Marcel Dekker, Inc. 2001.
2. Numerical methods with programs in C by T. Veerarajan and T. Ramachandran. Tata McGraw-Hill. 2006.
3. Sankara Rao, K., "Numerical Methods for Scientists and Engineers", Prentice Hall of India Pvt. Ltd, 3rd Edition, New Delhi, 2007
4. Sastry, S.S., "Introductory Methods of Numerical Analysis", PHI Learning Pvt. Ltd, 5th Edition, 2015.



VEL TECH HIGH TECH

Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

An Autonomous Institution

Approved by AICTE-New Delhi, Affiliated to Anna University, Chennai

Accredited by NBA, New Delhi & Accredited by NAAC with "A" Grade & CGPA of 3.27

Course code	21CH46T	Semester	IV				
Category	BASIC SCIENCE COURSE (BSC)			L	T	P	C
Course Title	ENVIRONMENTAL SCIENCE AND ENGINEERING (Only for Chemical Engineering)			3	0	0	3

COURSE OBJECTIVES:

- To study the nature, interrelationship between living organism and environment, biodiversity, natural resources, pollution control and waste management.
- To find and implement scientific, technological, economic and political solutions to environmental problems.
- To appreciate the importance of environment by assessing its impact on the human world.

PREREQUISITE:

- Basic awareness on environment.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C406.1	<i>Illustrate</i> the interrelationship between living organism and environment.	K2
C406.2	<i>Classify</i> the dynamic processes and the features of natural resources.	K2
C406.3	<i>Relate</i> public awareness, environmental pollution and its problem.	K2
C406.4	<i>Measure</i> the development and improvement in standard of living.	K2
C406.5	<i>Summarize</i> the knowledge about human health and welfare.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C406.1	1	-	-	-	-	-	1	-	-	-	-	-
C406.2	1	-	-	-	-	-	1	-	-	-	-	-
C406.3	2	-	-	-	-	-	1	-	-	-	-	-
C406.4	1	-	-	-	-	-	2	1	-	-	-	1
C406.5	1	-	-	-	-	-	1	1	-	-	-	1

Note: 1: Slight, 2: Moderate, 3: Substantial

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 12

Definition, scope and importance of environment-need for public awareness-concept of an ecosystem-structure and function of an ecosystem-producers, consumers and decomposers-energy flow in the ecosystem-ecological succession-food chains, food webs and ecological pyramids-Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)-Introduction to biodiversity definition: genetic, species and ecosystem diversity-biogeographical classification of India-value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values-Biodiversity at global, national and local levels-India as a mega-diversity nation-hot-spots of biodiversity-threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts-endangered and endemic species of India-conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Bio diversity and Health. Field study of common plants, insects, birds, etc., Field study of simple ecosystems -pond, river, hill slopes, etc.

UNIT II NATURAL RESOURCES 10

Forest resources: Use and over-exploitation, Deforestation, Governance, case studies-timber extraction, mining, dams and their effects on forests and tribal people-Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems-Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies-Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies-Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies -Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification-role of an individual in conservation of natural resources. Field study of local area to document environmental assets-river/forest/grassland/hill/mountain.

UNIT III ENVIRONMENTAL POLLUTION AND DISASTER MANAGEMENT 8

Definition-causes, effects and control measures of: (a) Air pollution (b) Water pollution(c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards, accidents and holocaust-solid waste management: causes, effects and control measures of municipal solid wastes-E waste and Scrap tyres-Recycling of Plastic, Glass and Paper wastes-role of an individual in prevention of pollution-pollution case studies-disaster management: floods, earthquake, cyclone and landslides- case studies. Field study of local polluted site-Urban/Rural/Industrial/Agricultural.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 8

From unsustainable to sustainable development-Equitable use of resources for sustainable lifestyles-urban problems related to energy-water conservation, rain water harvesting, watershed management-resettlement and rehabilitation of people; its problems and concerns, case studies-role of nongovernmental organization- environmental ethics: Issues and possible solutions-principles of green chemistry-climate change, global warming, acid rain, ozone layer depletion, case studies-wasteland reclamation-consumerism and waste products-environment protection act-Air (Prevention and Control of Pollution) act-Water(Prevention and control of Pollution) act-Wildlife protection act-Forest conservation act-environmental impact assessment- enforcement machinery involved in environmental legislation-central and state pollution control boards-Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT

7

Population growth, variation among nations-population explosion-family welfare programme-environment and human health-human rights-value education-women and child welfare-HIV/AIDS-SARS-Covid-19-role of information technology in environment and human health-Case studies.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Benny Joseph, Environmental Science and Engineering, Tata McGraw-Hill, New Delhi, 2014.
2. Anubha Kaushik, and Kaushik, C. P., Environmental Science and Engineering, New Age International Publishers, 6thEdition, 2019.

REFERENCES:

1. ErachBharucha, Textbook of Environmental Studies for Undergraduate Courses, 2nd Edition, University Grants Commission, Universities Press, 2013.
2. Gilbert Masters, Wendell Ela, Introduction to Environmental Engineering and Science, 3rdEdition, Pearson Education, 2015.
3. Tyler Miller, G., and Scott E. Spoolman, Environmental Science, Cengage Learning India Pvt. Ltd, Delhi, 2014.



VEL TECH HIGH TECH

Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

An Autonomous Institution

Approved by AICTE-New Delhi, Affiliated to Anna University, Chennai

Accredited by NBA, New Delhi & Accredited by NAAC with "A" Grade & CGPA of 3.27

Course code	21EN01OT	Semester	V				
Category	OPEN ELECTIVE COURSE			L	T	P	C
Course Title	FOREIGN LANGUAGE FRENCE (For All Branches)			3	0	0	0

COURSE OBJECTIVES:

- To understand and communicate (read, write and speak) in French.
- To facilitate students to develop proficiency in French communication.
- To make students infer the global purview of Francophone studies

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C001.1	Demonstrate their ability to use basic French structure.	K2
C001.2	Demonstrate their ability to use vocabulary.	K3
C001.3	Understand and respond to simple instructions .	K2
C001.4	Demonstrate basic written communication.	K3
C001.5	Converse Daily Activities in Simple Sentences.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
C001.1	1	2	2	1	1	2	3	1	1	-	-	-	-	-
C001.2	3	2	2	3	1	1	1	3	3	-	-	-	-	-
C001.3	1	2	2	1	1	2	3	1	1	-	-	-	-	-
C001.4	3	2	2	3	1	1	1	3	3	-	-	-	-	-
C001.5	1	2	2	1	1	2	3	1	1	-	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

UNIT I INITIATION AU FRANÇAIS 9

L'alphabet et les accents- Présentation – Salutations — les articles indéfinis - les articles définis-le pluriel des noms – les adjectives qualificatifs-conjugaisons.

UNIT II LES NOMBRES –LES JOURS DE LA SEMAINE 9

Les nombres –les jours de la semaine – les mois de l'année - les verbs en – ir au présent – negation : ne.....pas – présentatif : c'est....il est....elleest....

UNIT III LES MEMBERS DE LA FAMILLE ET ER AU PRESENT 9

Les members de la famille – l'heure et la date – les pays – les pronoms personnelssujets – les verbs en – er au present

UNIT IV SALUTATION ET INTERROGATOIRE 9

Les voeux – les directions -Le transport - les adjectives possessives- l'interrogation (qu'estce que c'est,comment, qui est –ceoù)

UNIT V CONVERSATIONS 9

Les repas – les boissons – les goûters - Conversations dans les petites

Total: 45 Periods

LEARNING RESOURCES:**TEXT BOOKS:**

1. Krishnan, Chitra., et al.,Le Tramway Volant - I, Leçons 0 – 6, Langers International, Inde, 2015 (latestupdatededition).
2. Grégoire, Maïia et Thiévenaz, Odile,Grammaire Progressive du Français, CLE International, Tours, France, 2017.

REFERENCES:

1. Bertenshaw, T. H., French Course Grammar, Chennai, Orient Longman, 2007.
2. Le Bescherelle 1, L'art de conjuguer, Paris, Hatier, 2017.
3. Oudot, Simone.,French Verbs and essentials of grammar, Lincolnwood, Passport books, 2018.
4. Barron's 501 French Verbs, Goyal Publishers & Distributors (P) Ltd, New Delhi, 2010.



VEL TECH HIGH TECH

Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

An Autonomous Institution

Approved by AICTE-New Delhi, Affiliated to Anna University, Chennai

Accredited by NBA, New Delhi & Accredited by NAAC with "A" Grade & CGPA of 3.27

Course code	21PH02OT	Semester	V				
Category	BASIC SCIENCE COURSE(BSC)			L	T	P	C
CourseTitle	FUNDAMENTALS OF PHOTOVOLTAICS AND ITS APPLICATIONS			3	0	0	3

COURSE OBJECTIVES:

- To introduce solar energy to the students
- To enable the students to understand the required physics involved in solar Photovoltaic
- To familiarize students with manufacturing methods in solar cell fabrication

PREREQUISITE:

- Basic Physics and Electronics

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C002.1	<i>Outline</i> the knowledge of solar radiation.	K2
C002.2	<i>Explain</i> the photovoltaic materials.	K2
C002.3	<i>Explain</i> the process of sand to silicon and different types of solar cells.	K2
C002.4	<i>Construct</i> various types of solar cells.	K3
C002.5	<i>Develop</i> the photovoltaic systems and its application.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C002.1	2	1	-	-	-	-	-	-	-	-	-	-
C002.2	3	2	1	-	-	-	1	-	-	-	-	1
C002.3	3	2	1	-	-	-	1	-	-	-	-	1
C002.4	2	1	-	-	-	-	-	-	-	-	-	-
C002.5	3	2	1	-	-	-	1	-	-	-	-	1

Note: 1: Slight, 2: Moderate, 3: Substantial

UNIT I SOLAR RADIATION 9

Energy scenario of world and India - climate change need for solar energy -Solar radiation, solar radiation outside Earth atmosphere, At Earth's surface, Measurement and estimation - solar radiation, direct and diffuse radiation, pyranometer and pyrliometer, solar radiation data of India and world, equations for predicting the availability of solar radiation.

UNIT II PHOTO VOLTAIC MATERIALS 9

Semiconductors, inorganic semiconductors, organic semiconductors, p-type and n- type semiconductors, PN junction, Absorption in semiconductors, PN junction under illumination. Diode equation, open circuit voltage, short circuit current, power, conversion efficiency.

UNIT III SOLAR CELL TYPES 9

Sand to silicon - Growth of single and polycrystalline silicon solar cells – Ga As solar cells – CIGS solar cells – Cd Te solar cells -amorphous-Si solar cells – DSSC- perovskite thin film solar cells.

UNIT IV MANUFACTURING OF SOLAR CELLS 9

Wafering –polishing – texturing- doping by diffusion- screen printing- thin film deposition on glass substrates-DC sputtering-RF sputtering-co-evaporation-spin coating-annealing-doctor blade coating-chemical bath deposition.

UNIT V PV SYSTEMS 9

Solar module characteristics- challenges and failure modules of solar panels-Solar modules in series- in parallel-solar array characteristics-PV systems-solar array-battery-inverter- stand-alone system street light - PV pumping – roof top system–storage-on grid and off grid systems-Design of a roof PV system.

Total: 45 Periods

LEARNING RESOURCES:**TEXTBOOKS:**

1. Martin A Green, Solar Cells Operating Principles Technology, System Applications, Prentice Hall, 1982.
2. Chetan Singh Solanki, Solar Photovoltaic: Fundamentals, Technologies And Applications 3rd Edition, PHI Learning; 3rd edition (9 May 2015).
3. Nelson, J. The Physics of Solar Cells. Imperial College Press, 2003.

REFERENCES:

1. Luque, A., and S. Hegedus, eds. Handbook of Photovoltaic Science and Engineering. John Wiley & Sons, Ltd, 2003.
2. Bube, R. Photovoltaic Materials. World Scientific Publishing Company, 1998.
3. A.S. Kapur, A Practical Guide for Total Engineering of MW capacity Solar PV Power Project, White Falcon Publishing; 2nd edition (16 March 2017).



VEL TECH HIGH TECH

Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

An Autonomous Institution

Approved by AICTE-New Delhi, Affiliated to Anna University, Chennai

Accredited by NBA, New Delhi & Accredited by NAAC with "A" Grade & CGPA of 3.27

Course code	21CY03OT	Semester	V				
Category	BASIC SCIENCE COURSE (BSC)			L	T	P	C
Course Title	RECENT TRENDS IN BATTERIES			3	0	0	3

COURSE OBJECTIVES:

- To imparting fundamental knowledge on electrochemical energy storage technologies.
- To understand the various battery technologies for electric vehicles.

PREREQUISITE:

- Basic Physics and Chemistry.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C003.1	<i>Knowledge</i> of basic electrochemical reactions.	K2
C003.2	<i>Elaborate</i> various battery technologies.	K2
C003.3	<i>Understand</i> synthesis and characterization of batteries.	K2
C003.4	<i>Acquire</i> concepts of battery performance.	K3
C003.5	<i>Analyze</i> battery systems for electric vehicle.	K4

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C003.1	2	1	-	-	-	-	-	-	-	-	-	-
C003.2	2	1	-	-	-	-	-	-	-	-	-	-
C003.3	2	1	-	-	-	-	-	-	-	-	-	-
C003.4	2	1	-	-	-	-	-	-	-	-	-	-
C003.5	3	2	2	-	-	1	1	-	-	-	-	1

Note: 1: Slight, 2: Moderate, 3: Substantial

UNIT I CONCEPTS OF BATTERIES AND ELECTROCHEMICAL PRINCIPLES 9

Components of Cells and Batteries - Classification of Cells and Batteries - Operation of a Cell - Theoretical Cell Voltage, Capacity, and Energy- Specific Energy and Energy Density of Practical Batteries - Upper Limits of Specific Energy and Energy Density - Electrode Processes - Electrical Double-Layer Capacity and Ionic Adsorption - Mass Transport to the Electrode Surface - Electroanalytical Techniques.

UNIT II OVERVIEW OF BATTERY TECHNOLOGY 9

History of Battery cells, Primary Battery, Secondary Battery, Performance parameters and operating variables of Battery, Lead Acid battery, Nickel Cadmium, Nickel Metal Hydride, Lithium Ion Batteries : Working, chemical reactions, comparison, future battery trends and challenges, Metal-Air Batteries, fuel cells, ultra capacitors.

UNIT III LITHIUM-ION/SODIUM-ION BATTERIES 9

Basic components in Lithium-ion & sodium-ion batteries: **Cathode Materials for Li-ion batteries:** LiCoO_2 , LiNiCoAlO_2 (NCA) & NaMnO_2 , NaNiMnCoO_2 (NCM). **Anode materials:** Graphite, activated carbon, silicon. Electrolyte – separators - Fabrication of Lithium-ion & sodium-ion batteries - charge –discharge capacity characteristics of Lithium-ion batteries-Advantages and limitations of cathode and anode materials.

UNIT IV BATTERY PERFORMANCE AND TESTING 9

Battery operating and performance parameters, Internal resistance, Charge-discharge characteristics of batteries, Measurement of current, voltage, temperature, Estimation of SOC: Coulomb Counting method, OCV method, Estimation of SoH, Capacity, efficiency.

UNIT V BATTERIES FOR ELECTRIC VEHICLE 9

Selection of battery for EVs & HEVs, Traction Battery Pack design, Requirement of Battery Monitoring, Battery State of Charge Estimation methods, Battery Cell equalization problem, thermal control, protection interface, Energy & Power estimation, Battery thermal management system, Battery Management System: Definition, Parts: Power Module, Battery, DC/DC Converter, load, communication channel, Battery Pack Safety, Battery Standards & Tests, Electrical safety of lithium-ion batteries.

Total: 45 Periods**LEARNING RESOURCES:****TEXT BOOKS:**

1. The handbook of lithium – ion battery pack design: Chemistry, components, types and terminology, John Warner (Elsevier).
2. Gianfranco Pistoia & Boryann Liaw, Behaviour of Lithium-Ion Batteries in Electric Vehicles Battery Health, Performance, Safety, and Cost, Springer (2018).

REFERENCES:

1. Lithium batteries and other electrochemical storage systems, Christian Glaize and Sylvie Geniès (ISTE and Wiley).
2. David Linden, Thomas B. Reddy, Hand Book of Batteries, Mcgraw-Hill, (2001).
3. Reiner Korthauer , Lithium-Ion Batteries: Basics and Applications, Springer (2017).
4. Electrochemical energy: Advanced materials and technologies, Edited by J Zhang (CRC press).



VEL TECH HIGH TECH

Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

An Autonomous Institution

Approved by AICTE-New Delhi, Affiliated to Anna University, Chennai

Accredited by NBA, New Delhi & Accredited by NAAC with "A" Grade & CGPA of 3.27

Course code	21CY040T	Semester	VI				
Category	OPEN ELECTIVE COURSE (OEC)			L	T	P	C
Course Title	GREEN CHEMISTRY (Common to All Branches)			3	0	0	3

COURSE OBJECTIVES:

- To make the students to learn various techniques of using green chemistry based on current requirements.
- To know about the various synthetic and analytical green methods.
- To learn about the bio-catalytic and microwave mediated reactions.

PREREQUISITE:

- Basic awareness on green chemistry.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C004.1	<i>Outline</i> the principles of green chemistry.	K2
C004.2	<i>Summarize</i> the microwave mediated organic reactions.	K2
C004.3	<i>Utilize</i> the new Ionic liquids and PTC for various reactions.	K3
C004.4	<i>Explain</i> the preparation techniques of supported and bio-catalysts for Green chemistry.	K2
C004.5	<i>Illustrate</i> the alternative techniques of green chemistry in chemical transformations.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C004.1	1	-	-	-	-	-	2	-	-	-	-	-
C004.2	1	-	-	-	-	-	2	-	-	-	-	-
C004.3	1	-	-	-	-	-	2	-	-	-	-	-
C004.4	1	-	-	-	-	-	2	-	-	-	-	-
C004.5	1	-	-	-	-	-	2	-	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS**No. of Credits: 3****UNIT I INTRODUCTION TO GREEN CHEMISTRY****9**

Green chemistry-relevance and goals, Anastas' twelve principles of green chemistry - Tools of green chemistry: alternative starting materials, reagents, catalysts, solvents and processes with suitable examples.

UNIT II MICROWAVE ASSISTED ORGANIC SYNTHESIS (MAOS)**9**

Microwave activation-advantages of microwave exposure-specific effects of microwave-Neat reactions-solid support reactions-Functional group transformations-condensations reactions-oxidations-reductions reactions -multi-component reactions.

UNIT III IONIC LIQUIDS AND PTC**9**

Introduction-synthesis of ionic liquids-physical properties-applications in alkylation-hydroformylations-exoxidations-synthesis of ethers-Friedel-craft reactions-Diels-Alder reactions-Knoevengal condensations-Wittig reactions-Phase transfer catalyst-Synthesis-applications

UNIT IV SUPPORTED CATALYSTS AND BIO-CATALYSTS FOR GREEN CHEMISTRY**9**

Introduction-the concept of atom economy-supported metal catalysts-mesoporous silicas-clays and supported clay catalysts-the use of Biocatalysts for green chemistry-modified bio catalysts-fermentations and biotransformations-fine chemicals by microbial fermentations-vitamins and amino acids- Baker's yeast mediated biotransformations-Bio-catalyst mediated Baeyer-Villiger reactions-Microbial polyester synthesis.

UNIT V ALTERNATIVE SYNTHESIS, REAGENTS AND REACTION CONDITIONS**9**

Ultrasound assisted reactions: Esterification, saponification, substitution reactions, Alkylations, oxidation, reduction, coupling reaction- A photochemical alternative to Friedel-crafts reactions-Dimethyl carbonate as a methylating agent-the design and applications of green oxidants-super critical carbon dioxide for synthetic chemistry.

Total: 45 periods**LEARNING RESOURCES:****TEXT BOOKS:**

1. Green Chemistry-Environmentally benign reactions-V.K. Ahluwalia. Ane Books India (Publisher) 2006.
2. Green Chemistry-Environment friendly alternatives- edited by RashmiSanghi& M. M. Srivastava, Narora Publishing House, 2012.

REFERENCES:

1. P.T.Anastas& J.C. Warner: Green Chemistry: Theory and Practice, Oxford University Press, New York 1998.
2. Green Chemistry-Designing Chemistry for the Environment-edited by Paul T. Anastas& Tracy C. Williamson. Second Edition, 1998.
3. Green Chemistry-Frontiers in benign chemical synthesis and processes-edited by Paul T. Anastas& Tracy C. Williamson. Oxford University Press, 1998.
4. A.S. Matlack: Introduction to Green Chemistry, Marcel Dekker, New York 2001.
5. G. Anilkumar &S.Saranya (eds): Green Organic Reactions. Materials Horizons: From Nature to Nanomaterials, Springer,Singapore 2021.
6. Mike Lancaster: Green Chemistry an Introductory Text. 2nd Ed., RSC Publishing, 2010.