Charotar University of Science and Technology, Gujarat
(**DRAFT**)
Re-designed Course Structure of UG in Statistical and Numerical Techniques

Course Code: **MA144**
Course Title: Engineering Mathematics - II

UG Engineering Programme	Semester
B. Tech. (All Branches)	Second

I RATIONALE

Mathematical concepts are imperative for engineering students to comprehend core technical subjects. This course enables students to solve basic ODEs and PDEs of the engineering systems, evaluate eigenvalues and eigenvectors of 2X2 and 3X3 matrices which is useful in engineering processing and understand statistical concepts like probabilities using binomial, Poisson, exponential and normal probability distributions.

II COMPETENCY

The basic purpose of this course is to help the student to acquire the following competency which is a ***macro-level industry-oriented task*** for this course**:**

- ***Apply techniques of differential equations (ODE/PDE), matrix algebra and statistics to engineering systems and processing utilized by industries.***

III COURSE OUTCOMES (COs)

Each of the following course outcomes (COs) are the meso-level industry-oriented sub-tasks of the abutilizedrred competency. Each CO is an integrated performance of the cognitive domain outcomes, practical outcomes and social skills. The industry expects the students to display them individually and collectively:

1) **Interpret** models of natural phenomena using differential equations and find its solution using standard methods.
2) **Interpret** physical problems analytically whose behavior can be described by linear and nonlinear differential equations.
3) ***Evaluate*** and explain significant of Eigenvalues and Eigenvectors of a square matrix, use Cayley-Hamilton's theorem to find inverse and power of a square matrix, construct LU decomposition of a square matrix.
4) ***Use*** advanced techniques to evaluate improper integrals, apply multiple integrals to find area and volume in engineering field.
5) **Interpret** and ***evaluate*** the problems using probability axioms, rules and Bayes theorem, use distributions such as Binomial, Poisson, Exponential and Normal to solve real world problems.

IV TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	100
4	1	0	4	70	30*	-	-	

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment*

***(*):** Under the **Theory PA**, out of 30 marks, **10 marks** are for **micro-project assessment** to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.*

V AFFECTIVE DOMAIN OUTCOMES (ADOs)

The following Affective Domain Outcomes (ADOs) are not specific to any of the above listed PrOs, but they are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he performs the series of practical exercises and other T-L strategies throughout the semesters.

1) Function as a team member.
2) Function as a team leader.
3) Follow ethics.

The level of achievement of the ADOs according to ***Krathwohl's 'Affective Domain Taxonomy'*** should gradually increase as planned below:

a) 'Responding Level' in 1st year
b) 'Valuing Level' in 2nd year
c) 'Organising Level' in 3rd year
d) 'Characterising Level' in 4th year.

VI UNDERPINNING THEORY COMPONENTS

The following topics are to be learned by the students and assessed by the teachers in order to develop the 'Apply' and above level sample Cognitive Domain learning outcomes denoted by unit outcomes (UOs) related to Revised Bloom's Taxonomy (RBT) given below for achieving the related COs to be integrated to perform the identified competency. More UOs could be added.

Unit No. & Title	Unit Outcomes (UOs) in Cognitive Domain (to develop COs required by industry)	Topics and Sub-topics
Unit – I First order and First-degree Ordinary Differential Equations	**CO1. Interpret** models of natural phenomena using differential equations and find its solution using standard methods. **CO2. Interpret** physical problems analytically whose behavior can be described by linear and nonlinear differential equations.	1.1 Formation of Ordinary Differential Equation 1.2 Concept of general and particular solution 1.3 Initial value problems 1.4 Solutions of first order and first degree

Unit No. & Title	Unit Outcomes (UOs) in Cognitive Domain (to develop COs required by industry)	Topics and Sub-topics
	1a. Interpret and evaluate order and degree of a differential equation. 1b. Apply an appropriate method to solve a first order first degree ordinary differential equation.	differential equations: Linear, Bernoulli, Exact and non-exact differential equations
Unit– II Higher Order Ordinary Linear Differential Equations	**CO1. <u>Interpret</u>** models of natural phenomena using differential equations and find its solution using standard methods. **CO2. <u>Interpret</u>** physical problems analytically whose behavior can be described by linear and nonlinear differential equations. 2a. Interpret and evaluate higher order linear differential equation with constant coefficient using variation of parameters and undetermined coefficients.	2.1 General Solution of Higher Order Ordinary Linear Differential Equations with Constant coefficients 2.2 Methods for finding particular integrals viz. variation of parameters and undetermined coefficients 2.3 Linear Differential Equation of higher order with variable coefficients: Legendre's Equations (Special case: Cauchy-Euler equation) 2.4 System of simultaneous first order linear differential equations
Unit– III Partial Differential Equations	**CO1. <u>Interpret</u>** models of natural phenomena using differential equations and find its solution using standard methods. **CO2. <u>Interpret</u>** physical problems analytically whose behavior can be described by linear and nonlinear differential equations. 3a. Create a partial differential equation from the family of surfaces. 3b. Determine solution of Lagrange's linear partial differential equation and some special types of nonlinear partial differential equations.	3.1 Formation of Partial Differential Equation 3.2 Lagrange's Linear Differential Equations 3.3 Special types of Nonlinear First Order Partial Differential Equation
Unit-IV	**CO3. <u>*Evaluate*</u>** and explain significant of Eigenvalues and Eigenvectors of a square	4.1 Revision of matrices and determinant

Unit No. & Title	Unit Outcomes (UOs) in Cognitive Domain (to develop COs required by industry)	Topics and Sub-topics
Matrix Algebra – II	matrix, use Cayley-Hamilton's theorem to find inverse and power of a square matrix, construct LU decomposition of a square matrix. 4a. Evaluate eigenvalues and eigenvectors. 4b. Apply Caylet-Hamilton's theorem to find the inverse of a matrix. 4c. Apply Crout's method to represent a matrix as multiplication of lower and upper triangular matrices.	4.2 Eigenvalues and Eigenvectors of matrices 4.3 Eigenvalues and Eigenvectors of special matrices 4.4 Cayley-Hamilton's Theorem and its applications 4.5 Crout's method of LU decomposition
Unit – V Improper and Multiple Integrals	**CO4.** ***Use*** advanced techniques to evaluate improper integrals, apply multiple integrals to find area and volume in the engineering field. 5a. Analyze convergence of improper integral. 5b. Evaluate improper integrals using beta and gamma function 5c. Evaluate double and triple integration 5d. Evaluate area and volume using double and triple integrals respectively.	5.1 Introduction to Improper integrals 5.2 Definitions and properties of Gamma, Beta and Error functions 5.3 Evaluation of double integrals 5.4 Change of order of double integration, Transformation to polar coordinates, Applications of double integrals: Area 5.5 Evaluation of triple integrals, Transformation cylindrical coordinates, Applications of triple integrals: Volume
Unit – VI Probability and Statistics	**CO5.** **Interpret** and ***evaluate*** the problems using probability axioms, rules and Bayes theorem, use distributions such as Binomial, Poisson, Exponential and Normal to solve real world problems. 6a. Evaluate central tendency and dispersion. 6b. Evaluate the chance of occurrence of an event using classical probability as well as probability distributions namely binomial, Poisson, exponential and normal.	6.1 Elementary Probability: Joint and Conditional probability and Bayes theorem 6.2 Discrete Probability Distributions: Binomial and Poisson 6.3 Continuous Probability Distributions: Exponential and Normal

TABLE OF SPECIFICATIONS (TOS) FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks						
			R Level	U Level	A Level	An Level	E Level	C Level	Total Marks
I	**First order and First degree Ordinary Differential Equations**	10	1	0	1	2	8	0	12
II	**Higher Order Ordinary Linear Differential Equations**	12	1	0	4	1	8	0	14
III	**Partial Differential Equations**	08	1	0	2	0	6	0	09
IV	**Matrix Algebra –II**	10	1	0	1	2	8	0	12
V	**Improper and Multiple Integrals**	12	1	0	4	1	8	0	14
VI	**Probability and Statistics**	08	1	0	2	0	6	0	09
Total		**60**	**6**	**0**	**14**	**6**	**44**	**0**	**70**

Legends: R= Remember; U= Understand; A= Apply; An= Analyse; E= Evaluate; C= Create; (Revised Bloom's taxonomy).

Note: This TOS shall be treated as a general guideline for students and teachers for distribution of marks. The actual distribution of marks in the question paper may vary slightly to fulfil the MiLOs.

VII SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various types of learning outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c) About ***15-20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature that can be understood without the teacher assistance are to be given to the students for ***self-directed learning***, but to be progressively assessed for their integration into the COs.
d) Teachers need to ensure by creating opportunities and provisions for ***co-curricular activities.***

VIII SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and

prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare 15 min. power point presentation on how to choose relay for the particular application.
b) Watch online videos on the different topics and related to applications topics to learn in depth.

IX COURSE PLAN

Unit No. & Title	Week No.	Learning Outcomes	Teaching method	Teaching media
Unit– I First order and First degree Ordinary Differential Equations	1	1a. Formation of Ordinary Differential Equation 1b. Concept of general and particular solution	Lecture with media	Black board
		1c. Initial value problems 1d. Solutions of first order and first degree differential equations: Linear	Lecture With media	Black board
	2	1e. Solutions of first order and first degree differential equations: Bernoulli	Lecture with media	Black board
		1f. Solutions of first order and first degree differential equations: Exact and non-exact differential equations	Lecture with media	Black board
	3	1g. Solutions of first order and first degree differential equations: Exact and non-exact differential equations	Lecture with media	Black board
Unit– II Higher Order Ordinary Linear Differential Equations		2a. General Solution of Higher Order Ordinary Linear Differential Equations with Constant coefficients	Lecture with media	Black board
	4	2b. Methods for finding particular integrals viz. variation of parameters	Lecture with media	Black board
		2c. Methods for finding particular integrals viz. variation of parameters and undetermined coefficients	Lecture with media	Black board
	5	2d. Linear Differential Equation of higher order with variable coefficients: Legendre's Equations (Special case: Cauchy-Euler equation)	Lecture with media	Black board

Unit No. & Title	Week No.	Learning Outcomes	Teaching method	Teaching media
		2e. Linear Differential Equation of higher order with variable coefficients: Legendre's Equations (Special case: Cauchy-Euler equation)	Lecture with media	Black board
	6	2f. System of simultaneous first order linear differential equations	Lecture with media	Black board
Unit– III Partial Differential Equations		3a. Formation of Partial Differential Equation	Lecture with media	Black board
	7	3b. Lagrange's Linear Differential Equations	Lecture with media	Black board
		3c. Special types of Nonlinear First Order Partial Differential Equation	Lecture with media	Black board
	8	3d. Special types of Nonlinear First Order Partial Differential Equation	Lecture with media	Black board
Unit– IV Matrix Algebra –II		4a. Revision of matrices and determinant 4b. Eigenvalues and Eigenvectors of matrices	Lecture with media	Black board
	9	4c. Eigenvalues and Eigenvectors of special matrices	Lecture with media	Black board
		4d. Cayley-Hamilton's Theorem and its applications	Lecture with media	Black board
	10	4d. Cayley-Hamilton's Theorem and its applications 4e. Crout's method of LU decomposition	Lecture with media	Black board
Unit– V Improper and Multiple Integrals	**11**	5a. Introduction to Improper integrals. 5b. Definitions and properties of Gamma, Beta and Error functions	Lecture with media	Black board
		5c. Evaluation of double integrals	Lecture with media	Black board
	12	5c. Evaluation of double integrals	Lecture with media	Black board

Unit No. & Title	Week No.	Learning Outcomes	Teaching method	Teaching media
		5d. Change of order of double integration, Transformation to polar coordinates		
	13	5e. Applications of double integrals: Area 5f. Evaluation of triple integrals, Transformation cylindrical coordinates, Applications of triple integrals: Volume	Lecture with media	Black board
Unit– VI Probability and Statistics	**14**	6a. Elementary Probability: Joint and Conditional probability and Bayes theorem 6b Discrete Probability Distributions: Binomial	Lecture with media	Black board
	15	6c. Discrete Probability Distributions: Binomial and Poisson 6d. Continuous Probability Distributions: Exponential and Normal	Lecture with media	Black board

XIV SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication including ISBN
1	Advanced Engineering Mathematics (10th Edition).	Kreyszig, Erwin	Jhon Wiley & Sons, India, 2010. ISBN: 978-0470458365
2	Higher Engineering Mathematics.	Dass, H. K. and Verma, Rajnish	S Chand & Co Pvt. Ltd., India, 2014. ISBN: 978-8121938907
3	A first course in probability	Ross, Sheldon	Pearson Education, Inc, 2014. ISBN: 978-0-13-603313-4
4	Higher Engineering Mathematics	Grewal, B. S.	KHANNA PUBLISHERS, Delhi, 2012. ISBN: 978-8193328491
5	Thomas' Calculus	Weir, Maurice D., Hass, Joel, Thomas, George B. and Finney, Ross L.	Pearson Addison Wesley, Boston, 2008 ISBN: 9780321489876
6	Calculus Early Transcendental	James Stewart	Brooks/Cole Pub Co, 2007 ISBN: 978-0495553809
7	Advanced Engineering Mathematics	C. R. Wylie and L. C. Barrett	McGraw-Hill Education, 1995. ISBN: 978-0070722064
8	Advanced Engineering Mathematics	Michael D. Greenberg	Pearson, 1988 ISBN: 978-0130105059
9	Probability and Statistical Inference	R. V. Hogg, E. A. Tanis and D. L. Zimmerman	Pearson Education, 2015 ISBN: 978-0-321-92327-1
10	Differential Equations and Their Applications	Zafar Ahsan	PHI Learning, 2017. ISBN: 978-81-203-5269-8

XV SOFTWARE/LEARNING WEBSITES

1. http://nptel.ac.in/courses/122107037/
2. http://nptel.ac.in/courses/111107108/
3. http://nptel.ac.in/courses/122103012/
4. http://nptel.ac.in/courses/122104018/
5. http://nptel.ac.in/courses/111106100/
6. http://nptel.ac.in/courses/122101003/
7. https://ocw.mit.edu/courses/mathematics/18-02-multivariable-calculus-fall-2007/lecture-notes/
8. https://nptel.ac.in/courses/111105041/

XVI PO-COMPETENCY-CO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO01	PSO02
CO1	3	2	1	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	-	-
CO3	3	1	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	1	-	-	-	-	-	-	-	-	-	-	-	-
CO5	2	2	1	2	1	1	1	-	-	-	-	-	-	-

XVII NAMES OF RESOURCE PERSONS

Jimitkumar R. Patel
Purvak K. Patel