Course Code	18MAB101T	Course Name	CALCULUS AND LINEAR ALGEBRA	Course Category	B	Basic Sciences	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR): *The purpose of learning this course is to:*

		Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*Application of Matrices in problems of Science and Engineering*			
CLR-2 :	*Utilize Taylor series, Maxima minima, composite function and Jacobian in solving rea- time application problems*			
CLR-3 :	*Apply the concept of Differential Equations in problems of Science and Engineering*			
CLR-4 :	*Utilize the concepts of radius of curvature, evolute, envelope in problems of Science and Engineering*			
CLR-5 :	*Application of Sequences and Series in all problems involving Science and Engineering*			
CLR-6 :	*Utilize appropriate mathematical techniques for the different solutions required in Science and Engineering applications*			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Apply Matrices, Eigenvalues and Eigen Vectors Reduce to Quadratics form in Science and Engineering problem solving*	2	80	80	H	-	H	-	-	-	-	-	H	-	-	H	-	-	-
CLO-2 :	*Apply Maxima and Minima, Jacobian, and Taylor series to solve problems in Science and Engineering*	2	85	80	H	-	-	H	H	-	-	-	-	-	-	-	-	-	-
CLO-3 :	*Solve the different types of Differential Equations in Science and Engineering applications*	2	85	80	-	H	-		-	-	-	-	H	-	-	H	-	-	-
CLO-4 :	*Identify Radius, Centre, envelope and Circle of of curvature and apply them in the problem solving*	2	90	90	H	H	-	H	-	-	-	-	H	-	-	H	-	-	-
CLO-5 :	*Apply convergence and divergence of series using different test and apply sequences and Series in the problem solving*	2	90	80	-	H	H	-	-	-	-	-	H	-	-	H	-	-	-
CLO-6 :	*Identify, Analyze and Apply mathematical techniques to arrive at solutions in Science and Engineering*	2	90	90	H		H	-	-	-	-	-	H	-	-	H	-	-	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	*Characteristic equation*	*Functions of two variables – Partial derivatives*	*Linear equations of second order with constant coefficients when PI=0 or exp.*	*Radius of Curvature – Cartesian coordinates*	*Series of Positive terms – Test of Convergence-*
	SLO-2	*Eigen values of a real matrix*	*Total differential*	*Linear equations of second order with constant coefficients when PI=sinx or cosx*	*Radius of Curvature – Cartesian coordinates*	*Comparison test – Integral test-*
S-2	SLO-1	*Eigen vectors of a real matrix*	*Total differential*	*Linear equations of second order with constant coefficients when PI=polynomial*	*Radius of Curvature – Polar coordinates*	*Comparison test – Integral test-*
	SLO-2	*Eigen vectors of a real matrix*	*Taylor's expansion with two variables up to second order terms*	*Linear eqn. of second order with constant coefficients when PI=exp. with sinx / Cosx*	*Radius of Curvature – Polar coordinates*	*Comparison test – Integral test-.*
S-3	SLO-1	*Properties of Eigen values*	*Taylor's expansion with two variables up to third order terms*	*Linear eqn. of second order with constant coefficients when PI= exp.I with polynomial*	*Circle of curvature*	*D'Alemberts Ratio test,*
	SLO-2	*Cayley – Hamilton theorem*	*Maxima and Minima*	*Linear eqn. of 2nd order with const. coeff. when PI=polynomial with sinax or cosax*	*Circle of curvature*	*D'Alemberts Ratio test,*
S-4	SLO-1	*Problem solving using tutorial sheet 1*	*Problem solving using tutorial sheet 4*	*Problem solving using tutorial sheet 6*	*Problem solving using tutorial sheet 11*	*Problem solving using tutorial sheet 14*
	SLO-2	*Problem solving using tutorial sheet 1*	*Problem solving using tutorial sheet 4*	*Problem solving using tutorial sheet 6*	*Applications of Radius of curvature in engineering*	*Problem solving using tutorial sheet 14*
S-5	SLO-1	*Finding A inverse using Cayley – Hamilton theorem*	*Maxima and Minima*	*Linear equations of second order variable coefficients*	*Centre of curvature*	*Raabe's root test.*
	SLO-2	*Finging higher powers of A using Cayley – Hamilton theorem*	*Maxima and Minima*	*Linear equations of second order variable coefficients*	*Centre of curvature*	*Raabe's root test.*
S-6	SLO-1	*orthogonal reduction of a symmetric matrix to diagonal form*	*Maxima and Minima*	*Homogeneous equation of Euler type*	*Centre of curvature*	*Covergent of Exponential Series*
	SLO-2	*orthogonal reduction of a symmetric matrix to diagonal form*	*Constrained Maxima and Minima by Lagrangian Multiplier method*	*Homogeneous equation of Legendre's Type*	*Evolute of a parabola*	*Cauchy's Root test*
S-7	SLO-1	*orthogonal reduction of a symmetric matrix to diagonal form*	*Constrained Maxima and Minima by Lagrangian Multiplier method*	*Homogeneous equation of Legendre's Type*	*Evolute of an ellipse*	*Log test*

	SLO-2	*orthogonal reduction of a symmetric matrix to diagonal form*	*Constrained Maxima and Minima by Lagrangian Multiplier method*	*Equations reducible to homogeneous form*	*Envelope of standard curves*	*Log test*
S-8	SLO-1	*Problem solving using tutorial sheet 2*	*Problem solving using tutorial sheet 5*	*Problem solving using tutorial sheet 9*	*Problem solving using tutorial sheet 12*	*Problem solving using tutorial sheet 15*
	SLO-2	*Problem solving using tutorial sheet 2*	*Problem solving using tutorial sheet 5*	*Problem solving using tutorial sheet 9*	*Applications of Curvature in engineering*	*Problem solving using tutorial sheet 15*
S-9	SLO-1	*Reduction of Quadratic form to canonical*	*Jacobians of two Variables*	*Equations reducible to homogeneous form*	*Beta Gamma Functions*	*Alternating Series: Leibnitz test*
	SLO-2	*Quadratic form to canonical form by orthogonal transformations*	*Jacobians of Three variables*	*Variation of parameters*	*Beta Gamma Functions and Their Properties*	*Alternating Series: Leibnitz test*
S-10	SLO-1	*Quadratic form to canonical form by orthogonal transformations*	*Jacobians problems*	*Variation of parameters*	*Sequences – Definition and Examples*	*Series of positive and Negative terms.*
	SLO-2	*Orthogonal matrices*	*Jacobians Problems*	*Simultaneous first order equations with constant co-efficient.*	*Series – Types of Convergence*	*Series of positive and Negative terms.*
S-11	SLO-1	*Reduction of quadratic form to canonical form*	*Properties of Jacobians and Problems*	*Simultaneous first order equations with constant co-efficient.*	*Series of Positive terms – Test of Convergence-*	*Absolute Convergence*
	SLO-2	*Reduction of quadratic form to canonical form*	*Properties of Jacobians and problems*	*Simultaneous first order equations with constant co-efficient.*	*Comparison test – Integral test-*	*Conditional Convergence*
S-12	SLO-1	*Problem solving using tutorial sheet 3*	*Application of Taylor's series Maxima Minima Jacobians in Engineering*	*Problem solving using tutorial sheet 10*	*Problem solving using tutorial sheet 13*	*Problem solving using tutorial sheet 13*
	SLO-2	*Applications of Matrices in Engineering*	*Application of Taylor's series Maxima Minima Jacobians in Engineering*	*Applications of Differential Equation in engineering*	*Problem solving using tutorial sheet 13*	*Applications Convergence of series in engineering*

Learning Resources	*1. B. H. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons,2006.* *2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.* *3. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi,2008*	*4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010* *5. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson,Reprint, 2002* *6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. V. Maheshwaran, CTS, Chennai, maheshwaranv@yahoo.com	*1. Dr. K. C. Sivakumar, IIT, Madras, kcskumar@iitm.ac.in*	*1. Dr. A. Govindarajan, SRMIST*
2. Dr. Sricharan Srinivasan, Wipro Technologies, sricharanms@gmail.com	*2. Dr. Nanjundan, Bangalore University, nanzundan@gmail.com*	*2. Dr. Srinivasan, SRMIST*

Course Code	18MAB102T	Course Name	ADVANCED CALCULUS AND COMPLEX ANALYSIS	Course Category	B	Basic Sciences	L	T	P	C
							3	1	0	4

Pre-requisite Courses	18MAB101T	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR): *The purpose of learning this course is to:*

		Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Evaluate Double and triple Integral and apply them in problems in Engineering Industries			
CLR-2 :	Evaluate Surface, Volume Integral are Application of Gauss theorem, Stokes and Green's theorem in Engineering fields			
CLR-3 :	Transform engineering problems into ODE, PDE and Integrals and solve them using Laplace / complex analytic methods			
CLR-4 :	To know the properties of Complex functions and apply them in the all Engineering fields			
CLR-5 :	Evaluate improper integrals involving complex functions using Residue theorem and apply them in Engineering fields			
CLR-6 :	Identify how Engineering problems can be transformed in to simple mathematical constructs and solve the same			

Course Learning Outcomes (CLO): *At the end of this course, learners will be able to:*

		Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Evaluate multiple integrals using change of variables	3	95	90	H	-	H	-	-	-	-	-	H	-	-	H	-	-	-
CLO-2 :	Apply techniques of vector calculus in problems involving Science and Engineering. Solving Ordinary Differential Equations	3	90	85	H	-	-	H	H	-	-	-	H	-	-	-	-	-	-
CLO-3 :	Apply techniques of Laplace Transforms and inverse transform for problems in Science and Engineering	2	85	80	-	H	-		-	-	-	-	H	-	-	H	-	-	-
CLO-4 :	Apply complex analytic functions and its properties in solving problems	3	80	80	H	H	-	H	-	-	-	-	H	-	-	H	-	-	-
CLO-5 :	Evaluate improper integrals using Residue theorem involving problems in Science and Engineering	2	80	90	-	H	H	-	-	-	-	-	H	-	-	H	-	-	-
CLO-6 :	Create mathematical constructs for engineering problems and identify solutions to solve them	3	90	80	H		H	-	-	-	-	-	H	-	-	H	-	-	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Evaluation of double integration Cartesian and plane polar coordinates	Review of vectors in 2,3 dimensions	Laplace Transforms of standard functions	Definition of Analytic Function – Cauchy Riemann equations	Cauchy's integral formulae - Problems
	SLO-2	Evaluation of double integration of plane polar coordinates	Gradient, divergence,	Transforms properties	Cauchy Riemann equations	Cauchy's integral formulae- Problems
S-2	SLO-1	Evaluation of double integration of plane polar coordinates	curl – Solenoidal	Transforms of Derivatives and Integrals	Properties of analytic function functions	Cauchy's integral formulae- Problems
	SLO-2	Evaluation of double integration of plane polar coordinates	Irrotational fields	Transform of derivatives and integrals	Determination of analytic function using – Milne-Thomson's method	Taylor's expansions with simple problems
S-3	SLO-1	Evaluation of double integral by changing of order of integration	Vector identities (without proof) – Directional derivatives	Initial value theorems (without proof) and verification for some problems	Determination of analytic function using – Milne-Thomson's method	Taylor's expansions with simple problems
	SLO-2	Evaluation of double integral by changing of order of integration	Line integrals	Final value theorems (without proof) and verification for some problems	Determination of analytic function using – Milne-Thomson's method	Laurent's expansions with simple problems
S-4	SLO-1	Problem solving using tutorial sheet 1	Problem solving using tutorial sheet 4	Problem solving using tutorial sheet 7	Problem solving using tutorial sheet 10	Problem solving using tutorial sheet 13
	SLO-2	Problem solving using tutorial sheet 1	Problem solving using tutorial sheet 4	Problem solving using tutorial sheet 7	Problem solving using tutorial sheet 10	Problem solving using tutorial sheet 13
S-5	SLO-1	Evaluation of double integral by changing of order of integration	Line integrals	Inverse Laplace transforms using partial fractions	Conformal mappings: magnification	Laurent's expansions with simple problems
	SLO-2	Area as a double integral (Cartesian)	Surface integrals	Inverse Laplace transforms using Partial fractions	Conformal mappings: rotation	Singularities
S-6	SLO-1	Area as a double integral (Cartesian)	Surface integrals	Inverse Laplace transforms using second shifting theorem	Conformal mappings: inversion	Types of Poles and Residues
	SLO-2	Area as a double integral (polar)	Volume Integrals	LT using Convolution theorem -problems only	Conformal mappings: inversion	Types of Poles and Residues

S-7	SLO-1	*Area as a double integral (polar)*	*Green's theorem (without proof),*	*LT using Convolution theorem -problems only*	*Conformal mappings: reflection*	*Cauchy's residue theorem (without proof)-*
	SLO-2	*Triple integration in Cartesian coordinates*	*Green's theorem (without proof),*	*ILT using Convolution theorem -problems only*	*Conformal mappings: reflection*	*Contour integration: Unit circle.*
S-8	SLO-1	*Problem solving using tutorial sheet 2*	*Problem solving using tutorial sheet 5*	*Problem solving using tutorial sheet 8*	*Problem solving using tutorial sheet 11*	*Problem solving using tutorial sheet 14*
	SLO-2	*Problem solving using tutorial sheet 2*	*Problem solving using tutorial sheet 5*	*Problem solving using tutorial sheet 8*	*Problem solving using tutorial sheet 11*	*Problem solving using tutorial sheet 14*
S-9	SLO-1	*Conversion from Cartesian to polar in double integrals*	*Gauss divergence theorem (without proof), verification*	*LT of periodic functions -problems only*	*bilinear transformation*	*Contour integration: Unit circle.*
	SLO-2	*Conversion from Cartesian to polar in double integrals*	*Gauss divergence theorem (without proof) applications to cubes.*	*LT of periodic functions -problems only*	*bilinear transformation*	*Contour integration: Unit circle*
S-10	SLO-1	*Triple integration in Cartesian coordinates*	*Gauss divergence theorem (without proof applications to parallelepiped.*	*Solve linear second order ordinary diff. equations with constant coefficient only*	*bilinear transformation*	*Contour integration: semicircular contour.*
	SLO-2	*Triple integration in Cartesian coordinates*	*Stoke's theorems (without proof) – Verification*	*Solve linear second order ordinary diff. equations with constant coefficient only*	*bilinear transformation*	*Contour integration: semicircular contour.*
S-11	SLO-1	*Triple integration in Cartesian coordinates*	*Stoke's theorems (without proof) – Applications to cubes*	*Solution of Integral equation and integral equation involving convolution type*	*Cauchy's integral theorem (without proof)*	*Contour integration: semicircular contour.*
	SLO-2	*Volume using triple Integral*	*Stoke's theorems (without proof) – Applications to parallelepiped only.*	*Solution of Integral equation and integral equation involving convolution type*	*Cauchy's integral theorem applications*	*Contour integration: semicircular contour.*
S-12	SLO-1	*Problem solving using tutorial sheet 3*	*Problem solving using tutorial sheet 6*	*Problem solving using tutorial sheet 9*	*Problem solving using tutorial sheet 12*	*Problem solving using tutorial sheet 15*
	SLO-2	*Application of Multiple integral in engineering*	*Application of Line and Volume Integrals in engineering*	*Application of Laplace Transform in engineering*	*Application of Bilinear Transformation and Cauchy Integral in engineering*	*Application Contour integration in engineering*

Learning Resources	*1. B. H. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons,2006.* *2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.* *3. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi,2008*	*4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010* *5. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson,Reprint, 2002* *6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. V. Maheshwaran, CTS, Chennai, maheshwaranv@yahoo.com	*1. Dr. K. C. Sivakumar, IIT, Madras, kcskumar@iitm.ac.in*	*1. Dr. A. Govindarajan, SRMIST*
2. Dr. Sricharan Srinivasan, Wipro Technologies, sricharanms@gmail.com	*2. Dr. Nanjundan, Bangalore University, nanzundan@gmail.com*	*2. Dr. Srinivasan, SRMIST*

Course Code	18MAB201T	Course Name	TRANSFORMS AND BOUNDARY VALUE PROBLEMS	Course Category	B	Basic Sciences	L	T	P	C
							3	1	0	4

Pre-requisite Courses	18MAB102T	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Describe types of Partial differential equations interpret solutions relate PDE to the respective branches of engineering			
CLR-2 :	Relate Fourier series expansion in solving problems under RMS value and Harmonic Analysis.			
CLR-3 :	Infer the most general form to the PDE and relate to half range sine and cosine series, as the case may be			
CLR-4 :	Evaluate the various types of integral transforms			
CLR-5 :	Conclude that the purpose of studying z transform is to solve linear difference equations having constant coefficients			
CLR-6 :	Predicting the importance of PDE, Fourier series, Boundary value problems and Fourier ,Z – transform applications			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Determine Partial differential equation	2	85	80	M	H	L	-	-	-	-	-	M	-	-	H	-	-	-
CLO-2 :	Explain the expansion of a discontinuous function as an infinite form of trigonometric sine and cosine series.	2	85	80	M	H	-	M	M	-	-	-	M	L	-	H	-	-	-
CLO-3 :	Decide a proper form of solution for the differential equations which are of hyperbolic and parabolic type	2	85	80	M	H	-	-	-	-	-	-	M	-	-	H	-	-	-
CLO-4 :	justify the relationship between aperiodic signals and linear combination of exponentials.	2	85	80	M	H	-	M	-	-	-	-	M	L	-	H	-	-	-
CLO-5 :	Relate signal analysis with that of z transform	2	85	80	M	H	L	-	-	-	-	-	M	-	-	H	-	-	-
CLO-6 :	Relate PDE, Fourier series, Boundary value problems, Fourier and Z transforms	2	85	80	L	L	L	H	H	H	L	H	H	H	-	H	-	-	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Formation of partial differential equation by eliminating arbitrary constants	Introduction of Fourier series - Dirichlet's conditions for existence of Fourier Series	Classification of second order partial differential equations	Introduction of Fourier Transforms	Introduction of Z-transform
	SLO-2	Formation of partial differential equation by eliminating two or more arbitrary constants	Fourier series –related problems in $(0,2\pi)$	Method of separation of variables	Fourier Transforms- problems	Z-transform-elementary properties
S-2	SLO-1	Formation of partial differential equation by eliminating arbitrary functions	Fourier series –related problems in $(-\pi,\pi)$	One dimensional Wave Equation and its possible solutions	Properties of Fourier transforms	Z-transform- change of scale property, shifting property
	SLO-2	Formation of partial differential equation by eliminating two or more arbitrary functions	Change of interval Fourier series –related problems in $(0,2l)$	One dimensional Wave Equation-initial displacement with zero initial velocity-type 1 Algebraic function	Standard results of Fourier transform	Z-transform of $a^n, \frac{1}{n}, \frac{1}{n+1}$
S-3	SLO-1	Formation of partial differential equation by eliminating arbitrary functions of the form $\phi(u,v)=0$	Fourier series –related problems in $(-l,l)$	One dimensional Wave Equation-initial displacement with zero initial velocity-type 2 Trigonometric function	Fourier Sine Transforms - problems	Z-transform of $\frac{1}{n^2}, \frac{1}{(n+1)^2}$
	SLO-2	Solution of first order non-linear partial differential equations-standard type I F(p,q)=0	Fourier series –half range cosine series related problems$(0,\pi)$	One dimensional Wave Equation-initial displacement with zero initial velocity-type 3 – Midpoint of the string is displaced	Fourier Cosine Transforms - problems	Z-transform of $r^n \cos n\theta$
S-4	SLO-1	Problem solving using tutorial sheet 1	Problem solving using tutorial sheet 4	Problem solving using tutorial sheet 7	Problem solving using tutorial sheet 10	Problem solving using tutorial sheet 13
	SLO-2					
S-5	SLO-1	Solution of first order nonlinear partial differential equations-standard type –II Clairaut's form	Fourier series –half range cosine series related problems$(0,l)$	One dimensional Wave Equation-initial displacement with non-zero initial velocity Type 1 Algebraic function	Properties of Fourier sine Transforms	Z-transform of $r^n \sin n\theta$
	SLO-2	Solution of first order non-linear partial differential equations-standard type III F(z, p, q)=0	Fourier series –half range sine series related problems$(0,\pi)$	One dimensional Wave Equation-initial displacement with non-zero initial velocity Type 2 Trigonometric function	Fourier sine Transforms applications	Initial value theorem

S-6	SLO-1	*Solution of first order non-linear partial differential equations-standard type-IV separation of variable f(x, p) = g(y, q)*	*Fourier series –half range sine series related problems* $(0, l)$	*Wave Equation-initial displacement with non-zero initial velocity Type 3 split function*	*Properties of Fourier cosine Transforms*	*Finial value theorem*
	SLO-2	*Lagrange's linear equation: Method of grouping*	*Parseval's Theorem (without proof)-related problems in Fourier series*	*One dimensional heat equation and its possible solutions*	*Fourier cosine Transforms applications*	*Inverse Z-transform- long division method*
S-7	SLO-1	*Lagrange's linear equation: Method of multipliers*	*Parseval's Theorem (without proof)-related problems in cosine series*	*One dimensional heat equation related problems*	*Convolution of two function*	*Inverse Z-transform, related problems, long division method*
	SLO-2	*More problems in Lagrange's linear equation: Method of multipliers*	*Parseval's Theorem (without proof)-related problems in sine series*	*One dimensional heat equation -Steady state conditions*	*Convolution Theorem*	*Inverse Z-transform, Partial fraction method*
S-8	SLO-1	*Problem solving using tutorial sheet 2*	*Problem solving using tutorial sheet 5*	*Problem solving using tutorial sheet 8*	*Problem solving using tutorial sheet 11*	*Problem solving using tutorial sheet 14*
	SLO-2					
S-9	SLO-1	*Linear Homogeneous partial differential equations of second and higher order with constant coefficients-CF and PI Type 1:* e^{ax+by}	*Introduction to Harmonic Analysis*	*One dimensional heat equation -Steady state conditions more problems*	*Parseval's Identity for Fourier transform*	*Inverse Z-transform, Partial fraction method related problems*
	SLO-2	*PI Type2.: sin(ax+by) or cos(ax+by)*	*Harmonic Analysis for finding harmonic in* $(0,2\pi)$	*One dimensional heat equation -Steady state conditions with zero velocity*	*Parseval's Identity for Fourier sine & cosine transforms*	*Inverse Z-transform - residue theorem method*
S-10	SLO-1	*Type 3: PI of polynomial*	*Harmonic Analysis for finding harmonic in* $(0,2l)$	*One dimensional heat equation -Steady state conditions with zero velocity more problems*	*Parseval's Identity for Fourier sine & cosine transforms applications*	*Inverse Z-transform - residue theorem method-problems*
	SLO-2	*Type 4 Exponential shifting* $e^{ax+by}f(x,y)$	*Harmonic Analysis for finding harmonic in periodic interval* $(0,T)$	*One dimensional heat equation -Steady state conditions with zero velocity more related problems*	*Fourier Transforms Using Differentiation property*	*Convolution theorem (without proof)*
S-11	SLO-1	*Linear Homogeneous partial differential equations of second and higher order with constant coefficients type 5 General rule*	*Harmonic Analysis for finding cosine series*	*Steady state conditions and Non-zero boundary conditions- related problems*	*Solving integral equation*	*Convolution theorem applications*
	SLO-2	*Applications of Partial differential equations in Engineering*	*Harmonic Analysis for finding sine series*	*Steady state conditions and Non-zero boundary conditions- more problems*	*Self-reciprocal using Fourier Transform, sine and cosine transform*	*Solution of linear difference equations with constant coefficients using Z-transform*
S-12	SLO-1	*Problem solving using tutorial sheet 3*	*Problem solving using tutorial sheet 6*	*Problem solving using tutorial sheet 9*	*Problem solving using tutorial sheet 12*	*Problem solving using tutorial sheet 15*
	SLO-2	*Problem solving using tutorial sheet 3*	*Problem solving using tutorial sheet 6*	*Problem solving using tutorial sheet 9*	*Problem solving using tutorial sheet 12*	*Problem solving using tutorial sheet 15*

Learning Resources	*1. B. H. Erwin kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons,2006* *2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 43rd Edition, 2015* *3. Veerarajan T., Transforms and Partial Differential Equations, Tata McGraw-Hill, New Delhi,2012*	*4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 3rd Edition, 2010* *6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, for third semester, Laxmi Publications, 3rd Edition, 2014*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. V. Maheshwaran, CTS, Chennai, maheshwaranv@yahoo.com	*1. Dr. K. C. Sivakumar, IIT, Madras, kcskumar@iitm.ac.in*	*1. Dr. A. Govindarajan, SRMIST*
2. Dr. Sricharan Srinivasan, Wipro Technologies, sricharanms@gmail.com	*2. Dr. Nanjundan, Bangalore University, nanzundan@gmail.com*	*2. Prof. Ganapathy Subramanian K S, SRMIST*

Course Code	18MAB202T	Course Name	NUMERICAL METHODS FOR ENGINEERS	Course Category	BS	Basic Sciences	L	T	P	C
							3	1	0	4

Pre-requisite Courses	18MAB102T	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	Apply the numerical techniques for solutions of algebraic, transcendental and simultaneous equations.	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLR-2 :	Apply the concept of interpolation for finding intermediate values of a well-known data.																		
CLR-3 :	Apply the concept of numerical differentiation and integration in physical problems.																		
CLR-4 :	Apply the numerical techniques for solutions of ordinary differential equations.																		
CLR-5 :	Apply the numerical techniques for solutions of partial differential equations																		
CLR-6 :	Acquired analytical ability in solving mathematical problems numerically as applied to the respective branches of Engineering.																		
Course Learning Outcomes (CLO):	At the end of this course, learners will be able:																		
CLO-1 :	To solve the algebraic, transcendental and simultaneous equations.	3	85	80	M	H	L						M	L		H			
CLO-2 :	To find the finite differences and interpolation.	3	85	80	M	H		M	M				M			H			
CLO-3 :	To solve numerical Differentiation and integration.	3	85	80	M	H							M			H			
CLO-4 :	To solve the numerical solutions of ordinary differential equations.	3	85	80	M	H		M					M	L		H			
CLO-5 :	To solve the numerical solutions of partial differential equations	3	85	80	M	H	L						M			H			
CLO-6:	To solve the problems numerically in science and engineering	3	85	80	M	H							M			H			

		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
Duration (hour)		12	12	12	12	12
S-1	SLO-1	Method of Least Squares – Curve	First and Higher order differences.	Numerical Differentiation.	Numerical solutions for ordinary	Numerical solutions for partial differential

		fitting.			differential equations.	equations.
	SLO-2	Fitting a straight line.	Forward differences and backward differences.	Newton's forward difference formulae to compute first and higher order derivatives.	Solution by Taylor's series method.	Classification of partial differential equations.
S-2	SLO-1	Fitting a parabola.	Central Differences.	Newton's backward differences formulae to compute first and higher order derivatives.	Solutions of First order simultaneous differential equations by Taylor's series method.	Solution of Elliptic Equations.
	SLO-2	Calculation of the sum of the squares of the residuals of straight line and parabola.	Operators– Relations between the operators.	Problems by Newton's forward and backward differences formulae.	Euler's method.	Solution of Laplace Equations by Leibmann's Iterative process.
S-3	SLO-1	Solution of Algebraic and Transcendental equations.	Interpolation – Newton-Gregory Forward Interpolation formulae.	Applications of Newton's forward difference formulae to compute first and higher order derivatives.	Applications of Euler's method.	Solution of Laplace Equations by Leibmann's Iterative process.
	SLO-2	Newton-Raphson method.	Interpolation – Newton-Gregory Backward Interpolation formulae.	Applications of Newton's backward difference formulae to compute first and higher order derivatives.	Improved Euler's method.	Solution of Poisson Equations.
S-4	SLO-1	Problem solving using tutorial sheet 1.	Problem solving using tutorial sheet 4.	Problem solving using tutorial sheet 7.	Problem solving using tutorial sheet 10.	Problem solving using tutorial sheet 13.
	SLO-2	Problem solving using tutorial sheet 1.	Problem solving using tutorial sheet 4.	Problem solving using tutorial sheet 7.	Modified Euler's method	Problem solving using tutorial sheet 13.
S-5	SLO-1	Bisection method and its applications.	Additional problems using Newton-Gregory Forward Interpolation formulae.	Additional problems for Newton's forward formulae to compute the application problems.	Applications of Improved and Modified Euler's method.	Problems for Poisson Equations.
	SLO-2	Problems using bisection method.	Additional problems using Newton-Gregory Backward Interpolation formulae.	Additional problems for Newton's backward formulae to compute the application problems.	Runge-Kutta method of fourth order.	Additional problems for Poisson Equations.
S-6	SLO-1	Regula-Falsi method.	Divided differences.	Numerical Integration.	Solution by Runge-Kutta method of fourth order.	Solution of Parabolic equations.
	SLO-2	Problems using false position method.	Formation of divided difference table.	Trapezoidal rule.	Additional problems using Runge-Kutta method of fourth	Bendre-Schmidt formula.

					order.	
S-7	SLO-1	Solution of system of equations Direct Method - Gauss Elimination method.	Properties of Divided differences.	Simpson's one third rule.	Predictor-Corrector Methods.	Bendre-Schmidt formula.
	SLO-2	Solution of system of equations Direct Method – Gauss-Jordan method.	Properties of Divided differences.	Simpson's three eighth rule.	Milne-Thomson Method.	Bendre-Schmidt formula.
S-8	SLO-1	Problem solving using tutorial sheet 2.	Problem solving using tutorial sheet 5.	Problem solving using tutorial sheet 8.	Problem solving using tutorial sheet 11.	Problem solving using tutorial sheet 14.
	SLO-2	Problem solving using tutorial sheet 2.	Problem solving using tutorial sheet 5.	Problem solving using tutorial sheet 8.	Problems for Milne-Thomson Method.	Problem solving using tutorial sheet 14.
S-9	SLO-1	Solution of system of equations Iterative Method – Gauss- Jacobi method.	Newton's Divided difference formula.	More problems using Trapezoidal rule.	Application of Milne-Thomson Method.	Crank-Nicolson formula.
	SLO-2	Problems using Gauss-Jacobi method.	Problems by Newton's Divided difference formula.	More problems using Simpson's one third rule.	Adam's Bashforth method.	Crank-Nicolson formula.
S-10	SLO-1	Solution of system of equations Iterative Method – Gauss-Seidal method.	Additional problems by Newton's Divided difference formula.	More problems using Simpson's three eighth rule.	Problems using Adam's Bashforth method.	Crank-Nicolson formula.
	SLO-2	Problems using Gauss- Seidal method.	Lagrange's Interpolation formula.	Applications of Trapezoidal rule – Simpson's one third rule and Simpson's three eighth rules.	Application of Adam's Bashforth method.	Solution of Hyperbolic equations.
S-11	SLO-1	Power method.	Problems by Lagrange's Interpolation formula.	Application problems for Trapezoidal rule – Simpson's one third rule and Simpson's three eighth rules.	Additional problems for Milne-Thomson Method.	Solution of Hyperbolic equations by Explicit formula.
	SLO-2	Finding Eigen values by power method.	Inverse interpolation.	Applications problems for Trapezoidal rule – Simpson's one third rule and Simpson's three eighth rules.	Additional problems for Adam's Bash forth Method	More problems in Hyperbolic equations using Explicit formula.
S-12	SLO-1	Problem solving using tutorial sheet 3.	Problem solving using tutorial sheet 6.	Problem solving using tutorial sheet 9.	Problem solving using tutorial sheet 12.	Problem solving using tutorial sheet 15.
	SLO-2	Applications of numerical techniques to solve	Application of interpolation for finding intermediate	Applications of Numerical integration.	Applications of ordinary differential equation.	Applications of partial differential equation.

		algebraic, transcendental and simultaneous equations	values of a well-known data..			

Learning Resources	1. B.S. Grewal, Numerical Methods in engineering and science, Khanna Publishers, 42nd edition, 2012. 2. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI, 4th edition, 2005. 3. E. Balagurusamy, Computer Oriented Statistical and Numerical Methods – Tata McGraw Hill., 2000. 4. M.K.Jain, SRK Iyengar and R.L.Jain, Numerical Methods for Scientific and Engineering Computation, Wiley Eastern Ltd., 4th edition, 2003. 5. Dr. M.K. Venkataraman, Numerical Methods in Science and Engineering, National Publishing Co., 2005.

	Level of Thinking	Continuous Assessment				Final Examination (50%)
		CLA – 1 (10%)	CLA – 2 (15%)	CLA – 3 (15%)	CLA –4 (10%) #	
Level 1	Remember Understand	40 %	30 %	30 %	30 %	30 %
Level 2	Apply Analyze	40 %	40 %	40 %	40 %	40 %
Level 3	Evaluate Create	20 %	30 %	30 %	30 %	30 %

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,
SLO – Session Learning Outcome

Course Designers

(a) Experts from Industry

1	*Mr.V.Maheshwaran*	*CTS, Chennai*	*maheshwaranv@yahoo.com*				

(b) Experts from Higher Technical Institutions

3	*Dr.K.C.Sivakumar*	*IIT, Madras*	*kcskumar@iitm.ac.in*	4	*Dr.Nanjundan*	*Bangalore University*	*nanzundan@gmail.com*

(b) Internal Experts

5	*Dr.A.Govindarajan*	*SRMIST*	govindarajan.a@ktr.srmuniv.ac.in	6	*Dr.Sundarammal kesavan*	*SRMIST*	*sundarammal.k@ktr.srmuniv.ac.in*

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ATTRACT AND BUILD PEOPLE in a rewarding and inspiring environment by fostering freedom, empowerment, creativity and innovation.

CLAT-1 – 21-01-2020
CLAT-2 – 25-02-2020
CLAT-3 – 06-04-2020

Last working Date : 24-04-2020

Dr. VIJAYAKUMAR
Course Coordinator

HOD / Maths
2/1/2020

Course Code	18MAB203T	Course Name	PROBABILITY AND STOCHASTIC PROCESSES	Course Category	BS	Basic Sciences	L	T	P	C
							3	1	0	4

Pre-requisite Courses	18MAB201T	Co-requisite Courses	NIl	Progressive Courses	NIL
Course Offering Department	Mathematics	Data Book / Codes/Standards	Statistical tables		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Describe the applications on discrete and continuous random variables.	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Assess the applications of two dimensional random variables.	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLR-3 :	Infer the various modes of convergence of random variables and their limit theorems.																		
CLR-4 :	Relate the specialized knowledge in random processes in signals and systems.																		
CLR-5 :	Determine the applications of spectral density functions and linear time invariant systems																		
CLR-6:	Interpret random variables and stochastic processes in the application of practical engineering problems.																		
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																		
CLO-1 :	Compare the fundamentals between discrete and continuous random variables.	3	85	80	M	H	L						M	L		H			
CLO-2 :	Choose the model and analyze systems using two dimensional random variables.	3	85	80	M	H		M	M				M			H			
CLO-3 :	Describe limit theorems using various inequalities.	3	85	80	M	H							M			H			
CLO-4 :	Interpret the characteristics of random processes.	3	85	80	M	H		M					M	L		H			
CLO-5 :	Evaluate problems on spectral density functions and linear time invariant systems.	3	85	80	M	H	L						M			H			
CLO-6:	Explain how random variables and stochastic processes can be described and analyzed.	3	85	80	M	H							M			H			

		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
Duration (hour)		12	12	12	10	14
S-1	SLO-1	One dimensional random variable: Discrete Case-Probability function, Cumulative Distribution Function	Two dimensional random variables-Discrete case	Limit theorems--Markov's inequality	Random Processes-Introduction	Power spectral density function- properties
	SLO-2	Continuous random variable-Probability density function	Probability function of (X,Y)-Marginal probability distribution	Chebyshev's inequality without proof	Classification of random processes	Proof of properties
S-2	SLO-1	Cumulative distribution function-properties	Conditional probability distribution of (X,Y)	Chebyshev's inequality - Applications	Distribution of the process	Problems on power spectral density function
	SLO-2	Problems on one dimensional random variables	Problems on discrete random variables	Chebyshev's inequality – Applications using Binomial distribution	Averages of the process	Problems on power spectral density function
S-3	SLO-1	Expectation, variance	Continuous random variables-Joint PDF	Chebyshev's inequality– Applications using Exponential distribution	Stationary ,SSS,WSS processes	Power density spectrum
	SLO-2	Moments-raw and central moments	Marginal Probability distributions	The weak law of large numbers	Problems on stationary and SSS processes	Problems based on power density spectrum
S-4	SLO-1	**Problem solving using tutorial sheet 1**	**Problem solving using tutorial sheet 4**	**Problem solving using tutorial sheet 7**	**Problem solving using tutorial sheet 10**	**Problem solving using tutorial sheet 13**
	SLO-2	**Problem solving using tutorial sheet 1**	**Problem solving using tutorial sheet 4**	**Problem solving using tutorial sheet 7**	**Problem solving using tutorial sheet 10**	**Problem solving using tutorial sheet 13**
S-5	SLO-1	Characteristic function - properties	Conditional probability distribution of (X,Y)	Central limit theorem without proof	Problems on WSS process	Linear system with random inputs
	SLO-2	Characteristic function	Problems on continuous two dimensional random variables	Central limit theorem - Applications	Problems on WSS process	Representation of system in the form of convolution

S-6	**SLO-1**	Binomial distribution -moments	Independent random variables	Central limit theorem- Applications using Poisson random variables	Autocorrelation function - properties	Unit impulse response of the system
	SLO-2	Binomial distribution- Applications	Cumulative distribution function-properties of F(x,y)	Central limit theorem- Applications using Exponential random variables	Proof of properties	Properties
S-7	**SLO-1**	Poisson distribution-moments	Expected values of two dimensional random variables	The strong law of large numbers	Problems on autocorrelation function	Applications of unit impulse function
	SLO-2	Poisson distribution - Applications	Covariance and correlation	The strong law of large numbers	Application of autocorrelation function	Einstein Weiner- Khinchine Relationship
S-8	**SLO-1**	**Problem solving using tutorial sheet 2**	**Problem solving using tutorial sheet 5**	**Problem solving using tutorial sheet 8**	**Problem solving using tutorial sheet 11**	**Problem solving using tutorial sheet 14**
	SLO-2	**Problem solving using tutorial sheet 2**	**Problem solving using tutorial sheet 5**	**Problem solving using tutorial sheet 8**	**Problem solving using sheet 11**	**Problem solving using tutorial sheet 14**
S-9	**SLO-1**	Exponential distribution- moments	Conditional expected values	One sided Chebychev's inequality	Cross correlation- properties	Problems on Khinchine relationship
	SLO-2	Exponential distribution- Applications	Problems on uncorrelated random variables	Cauchy Schwartz inequality	Proof of properties	Cross power density spectrum-properties
S-10	**SLO-1**	Normal Distribution-moments	Functions of two dimensional random variables	Chernoff bounds	Problems on cross correlation function	Proof of properties
	SLO-2	Normal Distribution-Applications	Probability density functions of the type Z=XY	Chernoff bounds for the standard normal variate	Ergodicity	Cross power density spectrum-problems
S-11	**SLO-1**	Function of a random variable	Probability density functions of the type Z=X-Y	Chernoff bounds for the Poisson random variate	Mean ergodic process	Cross power density spectrum
	SLO-2	Function of a random variable	Probability density functions of the type Z=X/Y	Jenson's inequality	Mean ergodic theorem	Cross power density spectrum
S-12	**SLO-1**	**Problem solving using tutorial sheet 3**	**Problem solving using sheet 6**	**Problem solving using tutorial sheet 9**	**Problem solving using tutorial sheet 12**	**Problem solving using tutorial sheet 15**
	SLO-2	**Applications of random variables in engineering**	**Application of two dimensional random variables in Engineering**	**Applications of Central limit Theorem in engineering**	**Applications of random process in engineering**	**Applications Power spectral density functions in engineering**
Learning Resources		1. A. Papoulis, S. Uniikrishna Pillai, Probability,Random Variables and Stochastic Processes 4'th Edition,Mcgraw Hill, 2002.				
		2. Henry Stark, Probability and Random Processes with Applications to Signal Processing,Third Edition, Pearson				
		3. Veerarajan T., Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks, 4th Edition, McGraw-Hill Education, New Delhi,2015				
		4. Sheldon Ross , Afirst course in Probability, Sixth Edition, 2011				
		5. S.C. Gupta, V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 11th Edition, 2015.				

	Level of Thinking	***Continuous Assessment***				***Final Examination (50%)***
		CLA – 1 (10%)	***CLA – 2 (15%)***	***CLA – 3 (15%)***	***CLA – 4 (10%)***	
Level 1	***Remember***	***40%***	***30%***	***30%***	***40%***	***30%***
	Understand					
Level 2	***Apply***	***40%***	***40%***	***40%***	***40%***	***40%***
	Analyze					
Level 3	***Evaluate***	***20%***	***30%***	***30%***	***20%***	***30%***
	Create					

 # CA – 3 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,
SLO – Session Learning Outcome

Course Designers						
	(a) Experts from Industry					
1	***Mr.V.Maheshwaran***	***CTS, Chennai***	***maheshwaranv@yahoo.com***			
	(b) Experts from Higher Technical Institutions					
2	***Dr.K.C.Sivakumar***	***IIT, Madras***	***kcskumar@iitm.ac.in***	***3 Dr.Nanjundan***	***Bangalore University***	***nanzundan@gmail.com***
(c) Internal Experts						
4	***Dr.A.Govindarajan***	***SRMIST***	***govindarajan.a@ktr.srmuniv.ac.in***	***5 Dr.Srinivasan***	***SRMIST***	

To emerge as a World - Class University in creating and disseminating knowledge, and providing students a unique learning experience in Science, Technology, Medicine, Management and other areas of scholarship that will best serve the world and betterment of mankind.

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Course Code	18MAB204T	Course Name	PROBABILITY AND QUEUEING THEORY	Course Category	B	Basic Sciences	L	T	P	C
							3	1	0	4

Pre-requisite Courses	18MAB102T	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR): *The purpose of learning this course is to:*

Course Learning Outcomes (CLO): *At the end of this course, learners will be able to:*

		Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLR-1 :	*Apply and evaluating probability using random variables*																		
CLR-2 :	*Gain the knowledge and acquire the application of distribution to find the probability using Theoretical distributions*																		
CLR-3 :	*To Assess the appropriate model and apply and soling any realistic problem situation to determine the probability*																		
CLR-4 :	*To interpret the decision using Markov queueing applications*																		
CLR-5 :	*To construct chain of decisions from the past situations using Markovians*																		
CLR-6 :	*Interpret random variables and Queuing theory in engineering problems.*																		
CLO-1 :	*Solving problems on Discrete and Continuous Random variables*	*3*	*85*	*80*	*M*	*H*	*L*	-	-	-	-	-	*M*	-	-	*H*	-	-	-
CLO-2 :	*Identifying Distribution and solving the problems in Discrete and Continuous Distribution*	*3*	*85*	*80*	*M*	*H*		*M*	*M*	-	-	-	*M*	*L*	-	*H*	-	-	-
CLO-3 :	*Decision Models using sampling techniques in Large and Small samples*	*3*	*85*	*80*	*M*	*H*	-	-	-	-	-	-	*M*	-	-	*H*	-	-	-
CLO-4 :	*Solving Queuing problems using Kendall's notation*	*3*	*85*	*80*	*M*	*H*	-	-	-	-	-	-	*M*	*L*	-	*H*	-	-	-
CLO-5 :	*To Evaluate the probability in uncertain situations using Markov chain rule*	*3*	*85*	*80*	*M*	*H*	*L*	*M*	-	-	-	-	*M*	-	-	*H*	-	-	-
CLO-6 :	*Solving and analyzing the problems in random variables and Queuing theory.*	*3*	*85*	*80*	*M*	*H*	-	-	-	-	-	-	*M*	-	-	*H*	-	-	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	*Probability Basic concepts and Axioms*	*Discrete Probability distribution*	*Sampling distribution, Null Hypothesis, Alternate Hypothesis*	*Introduction to F-test*	*Markov Process and Introduction of a Markov Chain*
	SLO-2	*Conditional probability, Multiplication theorem*	*Introduction to Binomial distribution*	*One tailed test, two tailed test*	*Problems on F-test*	*Past and Future - Step and State*
S-2	SLO-1	*Discrete and continuous Random variables*	*MGF, Mean, Variance of Binomial distribution*	*Level of significance, Critical region*	*Chi square test -Goodness of fit*	*One step Transition Probability N step transition Probability*
	SLO-2	*Probability mass function, cdf*	*Applications of Binomial distribution*	*Large samples test*	*Problems on Chi square test - Goodness of fit*	*Chapman-kolmogorov theorem definition*
S-3	SLO-1	*Continuous Random variables*	*Fit a Binomial distribution.*	*Student - t test Single Proportion*	*Problems on Chi-square test Independent- Attributes*	*Initial Probability distribution problems Using Markov Chain*
	SLO-2	*pdf and cdf applications*	*Introduction to Poisson Distribution*	*Two Sample proportions*	*Problems on Chi-square test Independent- Attributes with standard distributions*	*Initial Probability distribution problems Using Markov Chain*
S-4	SLO-1 SLO-2	*Problem solving using tutorial sheet 1*	*Problem solving using tutorial sheet 4*	*Problem solving using tutorial sheet 7*	*Problem solving using tutorial sheet 10*	*Problem solving using tutorial sheet 13*
S-5	SLO-1	*Expectation and Variance*	*MGF , Mean , Variance of Poisson distribution*	*Large sample test- Single Mean*	*Introduction to Queueing Theory and Applications. Kendall, notation*	*Classification of States of a Markov Chain*
	SLO-2	*Problems on Expectation and Variance*	*Applications of Poisson Distribution*	*Difference of Means*	*Introductio n to M/M/1 : infinity/ FIFO*	*Irreducible, Non irreducible, a period, Persistent, Non null Persistent*
S-6	SLO-1	*Moment Generating Function*	*Fit a Poisson Distribution*	*Problems on difference of Means*	*Ls, Lq, Ws,Wq*	*Problems on Classification of a Markov Chain*
	SLO-2	*Problems on MGF*	*Introduction , MGF Mean, Variance of Geometric distribution*	*Applications of Difference of Means*	*M/M/1 :Infinity /FIFO problems*	*Problem on Classification of a Markov Chain*
S-7	SLO-1	*Functions of Random variables*	*Applications of Geometric Distribution, problems on Memory less property*	*Introduction to small samples*	*M/M/1 :Infinity /FIFO problems*	*Classification of states of a Markov Chain*
	SLO-2	*Problems on Functions of Random variable*	*Introduction , MGF, Mean, Variance of Uniform Distribution*	*Introduction to small Samples*	*M/M/1 :Infinity /FIFO problems*	*Stationary and steady state*
S-8	SLO-1 SLO-2	*Problem solving using tutorial sheet 2*	*Problem solving using tutorial sheet 5*	*Problem solving using tutorial sheet 8*	*Problem solving using tutorial sheet 11*	*Problem solving using tutorial sheet 14*
S-9	SLO-1	*Tchebycheffs inequality*	*Applications of Uniform Distribution problems*	*Problems on single mean -small samples*	*Single Server Model with Finite System Capacity, Characteristics of the Model (M/M/1) : (K/FIFO)*	*Problems on Classification- State-stationary using Markov Chain*
	SLO-2	*Introduction to theoretical distribution*	*Introduction , MGF, Mean, Variance of Exponential distribution*	*Problems on single mean -small samples*	*Effective arrival rate*	*Problems on Stationary and steady state*

S-10	SLO-1	*Formula and application of Tchebycheffs inequality*	*Applications of Exponential distribution problems*	*Problems on difference of mean-small samples*	*Problems on Model (M/M/1) : (K/FIFO)*	*Problems on Ergodicity using Markov Chain*
	SLO-2	*Applications of chebychevs inequality*	*Introduction to Normal distribution*	*Problems on difference of mean-small samples*	*Problems on Model (M/M/1) : (K/FIFO)*	*Problems on Ergodicity using Markov Chain*
S-11	SLO-1	*Applications of chebychevs inequality using distribution*	*Applications of Normal distribution problems*	*Applications of paired - t test*	*Problems on Model (M/M/1) : (K/FIFO)*	*Problems on Ergodicity*
	SLO-2	*Problems practice using chebychevs inequality*	*Practical applications of Normal distribution*	*Problems of paired - t test.*	*Problems on Model (M/M/1) : (K/FIFO)*	*Problems on Ergodic and Non Ergodic Using Markovchains*
S-12	SLO-1	*Problem solving using tutorial sheet 3*	*Problem solving using tutorial sheet 6*	*Problem solving using tutorial sheet 9*	*Problem solving using tutorial sheet 12*	*Problem solving using tutorial sheet 15*
	SLO-2	*Applications of random variables in engineering*	*Applications of distribution to find the probability using Theoretical distributions*	*Applications of solving any realistic problem situation to determine the probability*	*Applications of Queueing decision models*	*Applications of constructing chain of decisions from the past situations using Monrovians*

Learning Resources	1. *Veerarajan T, Probability , Statistics and Random Processes, Tata Mc.Graw Hill, 1st Reprint 2004* 2. *S.C. Gupta, V.K.Kapoor, Fundamentals of Mathematical Statistics, 9th ed.,, Sultan Chand& Sons, 1999* 3. *Gross. D and Harri.C.M. Fundamentals of Queuing theory, John Wiley and Sons,1985* 4. *Trivedi K S, Probability and Statistics with reliability, Queueing and Computer Science Applications, prentice Hall of India, New Delhi, 1984* 5. *Allen .A.O. , Probability Statistics and Queueing theory, Academic Press*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40 %*	-	*30 %*	-	*30 %*	-	*30%*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30%*	-	*30%*	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. V. Maheshwaran, CTS, Chennai, maheshwaranv@yahoo.com	*1. Dr. K. C. Sivakumar, IIT, Madras, kcskumar@iitm.ac.in*	*1. Dr. A. Govindarajan, SRMIST*
2. Dr. Sricharan Srinivasan, Wipro Technologies, sricharanms@gmail.com	*2. Dr. Nanjundan, Bangalore University, nanzundan@gmail.com*	*2. Dr. V. Srinivasan, SRMIST*

Course Learning Syllabus *(includes Learning Outcomes & Learning Plan&Assessment Plan)*

Course Code	18MAB301T	Course Name	PROBABILITY AND STATISTICS	Course Category	BS	Basic Sciences	L	T	P	C
							3	1	0	4

Pre-requisite Courses	18MAB201T/18MAB203T	Co-requisite Courses	Nil	Progressive Courses	
Course Offering Department	Mathematics	Data Book / Codes/Standards	Statistical tables		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	To apply the basic rules and theorems of probability theory such as Baye's Theorem, to determine probabilities that help to solve engineering problems and to determine the expectation and variance of a random variable from its distribution.
CLR-2 :	To appropriately choose, define and/or derive probability distributions such as the Binomial, Poisson and Normal etc to model and solve engineering problems.
CLR-3 :	To learn how to formulate and test hypotheses about means, variances and proportions and to draw conclusions based on the results of statistical tests.
CLR-4 :	To understand how regression analysis can be used to develop an equation that estimates how two variables are related and how the analysis of variance procedure can be used to determine if means of more than two populations are equal.
CLR-5 :	To comprehend the fundamentals of quality control and the methods used to control systems and processes.
CLR-6:	Acquired the knowledge of probability and statistics and its applications to the respective branches of Engineering.

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO-1 :	To Pertain the Knowledge of probability concepts, to determine probabilities that help to solve engineering problems. and to determine the expectation and variance of a random variable from its distribution	3	85	80	M	H	L						M	L		H			
CLO-2 :	Gain familiarity in deriving probability distributions such as the Binomial, Poisson and Normal etc and apply them tn the problems involving Science and Engineering	3	85	80	M	H		M	M				M			H			
CLO-3 :	Acquire knowledge in formulating and testing hypotheses about means, variances and proportions	3	85	80	M	H							M			H			

CLO-4 :	*Getting the knowledge of Regression analysis, ANOVA and apply them in the problems in Science and Engineering*	*3*	*85*	*80*		*M*	*H*	*L*	*M*					*M*	*L*		*H*			
CLO-5 :	*Understanding the concept and applications of statistical quality control charts in technology and industries*	*3*				*M*	*H*	*M*						*M*			*H*			
CLO- 6:	*To solve the problems based on probability and statistics in science and engineering*	*3*	*85*	*80*		*M*	*H*							*M*			*H*			

		Learning Unit / Module 1	***Learning Unit / Module 2***	***Learning Unit / Module 3***	***Learning Unit / Module 4***	***Learning Unit / Module 5***
Duration (hour)		***12***	***12***	***12***	***12***	***12***
S-1	*SLO-1*	*probability concepts, Types of Events*	*Discrete distributions*	*Sampling*	*Correlation and Properties*	*Introduction and Process Control*
	SLO-2	*Axioms and theorems*	*Binomial distribution*	*Small and large samples*	*Karl pearson's correlation coefficient*	*Types of Control charts*
S-2	*SLO-1*	*Conditional probability Baye's theorem – without proof*	*M.G.F*	*Hypothesis Testing*	*Spearman's rank correlation coefficient*	*Control charts for variables*
	SLO-2	*Applications- Baye's Theorem.*	*mean*	*Large sample test-Test of significance for single proportion*	*Problems on rank correlation – non repeated ranks*	*Control chart for attributes*
S-3	*SLO-1*	*Random variables – Discrete case*	*variance*	*Test of significance for difference of proportions*	*Problems on repeated ranks*	*Control limits and drawing conclusions*
	SLO-2	*Probability Mass function*	*Fitting binomial distribution*	*More problems on test 2*	*Linear Regression lines and Properties*	*Control chart for mean and range when* $\overline{X}$ *and R data given directly*
S-4	*SLO-1*	*Problem solving using tutorial sheet 1*	*Problem solving using tutorial sheet 4*	*Problem solving using tutorial sheet 7*	*Problem solving using tutorial sheet 10*	*Problem solving using tutorial sheet 13*
	SLO-2	*Problem solving using tutorial sheet 1*	*Problem solving using tutorial sheet 4*	*Problem solving using tutorial sheet 7*	*Applications of correlation in engineering*	*Problem solving using tutorial sheet 14*
S-5	*SLO-1*	*Cumulative distribution function*	*Poisson distribution*	*Test of significance for single mean*	*regression coefficient Problems*	*More problems on* $\overline{X}$ *and R data given directly*
	SLO-2	*Mathematical expectation – discrete case*	*M.G.F, mean*	*Test of significance for difference of means*	*More problems in regression coefficients*	*Control chart for mean and range- when* $\overline{X}$ *and R data not given directly*
S-6	*SLO-1*	*Variance*	*variance*	*Small sample tests*	*Relation between correlation and regression*	*more problems on* $\overline{X}$ *and R data not given directly*
	SLO-2	*Probability density function*	*Fitting Poisson distribution*	*Student's t- test for single mean*	*problems on relation between correlation and regression*	*Control chart for mean and S.D when mean S.D values given directly*
S-7	*SLO-1*	*Cumulative distribution*	*Geometric distribution-M.G.F,*	*'t' test for the difference of*	*Applications of regression in*	*More problems on* $\overline{X}$ *and S*

		function	*mean, variance*	*means*	*engineering*	
	SLO-2	*Mathematical expectation- continuous case*	*Memory less property*	*More problems on t- test*	*Applications of regression in engineering*	*Control chart for mean and S.D when mean S.D values not given directly*
S-8	*SLO-1*	*Problem solving using tutorial sheet 2*	*Problem solving using tutorial sheet 5*	*Problem solving using tutorial sheet 8*	*Problem solving using tutorial sheet 11*	*Problem solving using tutorial sheet 14*
	SLO-2	*Problem solving using tutorial sheet 2*	*Problem solving using tutorial sheet 5*	*Problem solving using tutorial sheet 8*	*Problem solving using tutorial sheet 11*	*Problem solving using tutorial sheet 14*
S-9	*SLO-1*	*Variance*	*Continuous distribution:*	*Fisher's F-test*	*Introduction to ANOVAAnalysis of Variance – One way Classification*	*More problems on* $\overline{X}$ *and S*
	SLO-2	*Raw Moments*	*Uniform distribution – MGF, Mean, Variance*	*Test of significance for two sample variances*	*Problems on one way classification*	*Control chart for attributes- np chart*
S-10	*SLO-1*	*Central Moments*	*Exponential distribution - MGF, Mean, Variance*	*Chi square test- for goodness of fit*	*More problems on one way classification*	*More problems on np-chart*
	SLO-2	*Moment generating function*	*Memory less property*	*Problems on goodness of fit*	*ANOVA – two way classification*	*p- chart*
S-11	*SLO-1*	*MGF- discrete random variable*	*Normal distribution*	*Chi square test- for independence of attributes*	*Problems on two way classification*	*More problems on p- chart*
	SLO-2	*MGF- continuous random variable*	*Problems on Normal distribution*	*More problems on Chi square test- for independence of attributes*	*More problems on two way classification*	*Control chart for the defects in a single unit- c- chart*
S-12	*SLO-1*	*Problem solving using tutorial sheet 3*	*Problem solving using tutorial sheet 6*	*Problem solving using tutorial sheet 9*	*Problem solving using tutorial sheet 12*	*Problem solving using tutorial sheet 15*
	SLO-2	*Applications of Probability and Random variables in Engineering field*	*Application of distributions in Engineering*	*Applications and the importance of samplingin various fields of engineering*	*Engineering Applications of ANOVA, Correlation and Regression*	*Engineering applications of control chart*

Learning Resources

1. *S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.*
2. *Johnson. R.A., Miller &Freund's, Probability and Statistics for Engineers, 6th Edition, Pearson's Education, New Delhi, 2000.*
3. *Veerarajan T., Probability and Statistics, Tata McGraw-Hill, New Delhi, 2010.*
4. *Devore (JL), Probability and Statistics, 5th Edition: For Engineering and the Sciences.*
5. *Vijay K. Rohatgi., A.K. Md. Ehsanes Saleh, An Introduction to Probability and Statistics, 2 Edition, Wiley, 2008*

	Level of Thinking	Continuous Assessment				Final Examination (50%)
		CLAT– 1 (10%)	CLAT – 2 (15%)	CLAT – 3 (15%)	CLAT – 4 (10%) #	
Level 1	Remember	40 %	30 %	30 %	30 %	30 %
	Understand					
Level 2	Apply	40 %	40 %	40 %	40 %	40 %
	Analyze					
Level 3	Evaluate	20 %	30 %	30 %	30 %	30 %
	Create					

 # CA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,
SLO – Session Learning Outcome

Course Designers							
(a) Experts from Industry							
1	Mr.V.Maheshwaran	CTS, Chennai	maheshwaranv@yahoo.com				
(b) Experts from Higher Technical Institutions							
2	Dr.K.C.Sivakumar	IIT, Madras	kcskumar@iitm.ac.in	3	Dr.Nanjundan	Bangalore University	nanzundan@gmail.com
(b) Internal Experts							
4	Dr.A.Govindarajan	SRMIST	govindarajan.a@ktr.srmuniv.ac.in	5	Dr.Srinivasan	SRMIST	srinivasan.va@srmuniv.ac.in

To emerge as a World - Class University in creating and disseminating knowledge, and providing students a unique learning experience in Science, Technology, Medicine, Management and other areas of scholarship that will best serve the world and betterment of mankind.

MOVE UP through international alliances and collaborative initiatives to achieve global excellence.
ACCOMPLISH A PROCESS to advance knowledge in a rigorous academic and research environment.

ATTRACT AND BUILD PEOPLE in a rewarding and inspiring environment by fostering freedom, empowerment, creativity and innovation.

Course Code	18MAB302T	Course Name	DISCRTE MATHEMATICS FOR ENGINEERS	Course Category	BS	Basic Sciences	L	T	P	C
							3	1	0	4

Pre-requisite Courses	*18MAB102T*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Mathematics*	Data Book / Codes/Standards		*nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Apply set theory, functions and relations in storage, communication and manipulation of data*
CLR-2 :	*Apply number theory concepts in computer engineering such as public key crypto system.*
CLR-3 :	*Apply mathematical reasoning in computer science such as design of computer circuit, verification of programs.*
CLR-4 :	*Learning about groups, rings and fields. Solving problems on coding theory.*
CLR-5 :	*Using graph models in computer network and shortest path problems Apply graph coloring in problems involving scheduling and assignments.*
CLR-6 :	*Applymathematical reasoning, combinatorial analysis, algebraic structures and graph theory in solving mathematical problems as applied to the respective branches of Engineering.*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Problem solving in sets, relations and functions.*	3	85	80	M	H	L						M	L		H			
CLO-2 :	*Solving problems in basic counting principles, inclusion exclusion and number theory.*	3	85	80	M	H		M	M				M			H			
CLO-3 :	*Solving problems of mathematical logic, inference theory and mathematical induction.*	3	85	80	M	H							M			H			
CLO-4 :	*Gaining knowledge in groups, rings and fields. Solving problems in coding theory.*	3	85	80	M	H		M					M			H			
CLO-5 :	*Gaining knowledge in graphs and properties. Learning about trees, minimum spanning trees and graph coloring.*	3	85	80	M	H	L						M	L		H			
CLO-6 :	*Learning mathematical reasoning, combinatorial analysis, algebraic structures and graph theory.*	3	85	80	M	H							M			H			

		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
Duration (hour)		12	12	12	12	12
S-1	SLO-1	Sets and examples. Operations on sets.	Permutation and Combination	Propositions and Logical operators	Binary operation on a set- Groups and axioms of groups.	Basic concepts - Basic Definitions- degree and Hand shaking theorem.
	SLO-2	Laws of Set theory- Proving set identities using laws of set theory.	Simple problems using addition and product rules.	Truth values and truth tables.	Properties of groups.	Some Special Graphs – complete, regular and bipartite graphs.
S-2	SLO-1	Partition of a set – examples.	Principle of inclusion and exclusion	Propositions generated by a set-Symbolic writing using conditional and biconditional connectives.	Permutation group, equivalence classes with addition modulo m and multiplication modulo m.	Isomorphism of graphs – necessary conditions.
	SLO-2	Cartesian product of sets.	Problems using inclusion and exclusion principle.	Writing converse inverse and contra positive of a given conditional.	Cyclic groups and properties.	Isomorphism- simple examples.
S-3	SLO-1	Relations – Properties.	Pigeon-hole principle and generalized pigeon-hole principle.	Tautology, contradiction and contingency-examples.	Subgroups and necessary and sufficiency of a subset to be a subgroup.	*Paths, cycles and circuits.*
	SLO-2	Equivalence relation and partial order relation	Problems on pigeon-hole principle.	Proving tautology and contradiction using truth table method.	Group homomorphism and properties.	*Connectivity in undirected graphs – connected graphs and odd degree vertices.*
S-4	SLO-1	Problem solving using tutorial sheet 1	Problem solving using tutorial sheet 4	Problem solving using tutorial sheet 7	Problem solving using tutorial sheet 10	Problem solving using tutorial sheet 13
	SLO-2	Problem solving using tutorial sheet 1	Problem solving using tutorial sheet 4	Problem solving using tutorial sheet 7	Problem solving using tutorial sheet 10	Problem solving using tutorial sheet 13
S-5	SLO-1	Poset - Graphs of relations Digraphs	Divisibility and prime numbers.	Equivalences – truth table method to prove equivalences.	Rings- definition and examples..Zero devisors.	Eulerian and Hamiltonian graphs.
	SLO-2	Hasse diagram – problems.	Fundamental theorem of arithmetic – problems.	Implications- truth table method to prove implications.	Integral domain- definition , examples and properties.	Necessary and sufficient condition for a graph to be Eulerian- examples.
S-6	SLO-1	*Closures of relations- examples*	Finding prime factorization of a given number.	Laws of logic and some equivalences.	Fields – definition, examples and properties.	Matrix representation of graphs- adjacent and incidence matrices and examples.
	SLO-2	Transitive closure and warshall's algorithm	Some more problems using fundamental theorem of arithmetic.	Proving equivalences and implications using laws of logic.	Coding Theory – Encoders and decoders-Hamming codes.	Isomorphism using adjacency.
S-7	SLO-1	Functions – definitions, domain and range	Division algorithm- greatest common divisorand	Rules of inference – Rule P, Rule T and Rule	Hamming distance.	*Digraphs – in degree and out degree – Hand*

		of a function - examples	properties-problems.	CP	Error detected by an encoding function.	*shaking theorem.*
	SLO-2	Types of functions- one- one and onto-bijection- examples.	Euclid's algorithm for finding GCD(a,b)-examples..	Direct proofs	examples.	*Verification of hand shaking theorem in digraphs.*
S-8	SLO-1	Problem solving using tutorial sheet 2	Problem solving using tutorial sheet 5	Problem solving using tutorial sheet 8	Problem solving using tutorial sheet 11	Problem solving using tutorial sheet 14
	SLO-2	Problem solving using tutorial sheet 2	Problem solving using tutorial sheet 5	Problem solving using tutorial sheet 8	Problem solving using tutorial sheet 11	Problem solving using tutorial sheet 14
S-9	SLO-1	Composition of functions – examples.	Problems using Euclid's algorithm.	*Problems using direct method.*	Error correction using matrices.	Graph colouring – chromatic number-examples.
	SLO-2	Associatiivity of composition of functions – Identity and inverse of functions.	Least common Multiple(LCM)- relation between LCM and GCD.	*Problems using CP rule.*	Problems on error correction using matrices.	Four colourtheorem(statement only) and problems.
S-10	SLO-1	Necessary and sufficiency of existence of inverse of a function.	Problems on LCM.	Inconsistency and indirect method of proof.	Group codes-error correction in group codes-parity check matrix.	Trees – definitions and examples. Properties.
	SLO-2	Uniqueness of identity	Finding LCM and GCD using prime factorization.	Inconsistent premises and proof by contradiction (indirect method).	Problems on error correction in group codes.	Properties continued.
S-11	SLO-1	Inverse of composition	Finding GCD and LCM using Euclid's algorithm.	Principle of mathematical induction.	Procedure for decoding group codes.	Spanning trees – examples.
	SLO-2	Checking if a given function is bijection and if so, finding inverse, domain and range- problems.	More problems on GCD and LCM.	Problems based on Mathematical Induction	Problems on decoding group codes.	Kruskal's algorithm for minimum spanning trees.
S-12	SLO-1	Problem solving using tutorial sheet 3	Problem solving using tutorial sheet 6	Problem solving using tutorial sheet 9	Problem solving using tutorial sheet 12	Problem solving using tutorial sheet 15
	SLO-2	Applications of sets, relations and functions in Engineering.	Applications of sets, relations and functions in Engineering.	Applications of sets, relations and functions in Engineering.	Applications of sets, relations and functions in Engineering.	Applications of sets, relations and functions in Engineering.

Learning Resources

1. Kenneth H.Rosen, Discrete Mathematics and its Application, Seventh edition, Tata McGraw-Hill Publishing company PVT .Ltd., New Delhi, 2012.
2. Tremblay J. P. and Manohar R., Discrete Mathematical Structures with applications to Computer Science, Tata McGraw Hill Publishing Co., 35th edition,2008.
3. NarsingDeo, Graph Theory with applications to Engineering and Computer science, Prentice-Hall of India pvt. Ltd., New Delhi, 2004.
4. C.L. Liu, Elements of Discrete Mathematics, 4th Edition, McGraw Higher ED, 2012.
5. T.Veerarajan, Discrete Mathematics with Graph Theory and Combinatorics, Tata McGraw Hill, 2015.

	Level of Thinking	Continuous Assessment				Final Examination (50%)
		CLA – 1 (10%)	CLA – 2 (15%)	CLA – 3 (15%)	CLA –4 (10%) #	
Level 1	**Remember**	**40 %**	**30 %**	**30 %**	**30 %**	**30 %**
	Understand					
Level 2	**Apply**	**40 %**	**40 %**	**40 %**	**40 %**	**40 %**
	Analyze					
Level 3	**Evaluate**	**20 %**	**30 %**	**30 %**	**30 %**	**30 %**
	Create					

 # CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,
SLO – Session Learning Outcome

Course Designers

(a) Experts from Industry

1	*Mr.V.Maheshwaran*	*CTS, Chennai*	*maheshwaranv@yahoo.com*				
(b) Experts from Higher Technical Institutions							
2	*Dr.K.C.Sivakumar*	*IIT, Madras*	*kcskumar@iitm.ac.in*	3	*Dr.Nanjundan*	*Bangalore University*	*nanzundan@gmail.com*
(b) Internal Experts							
4	*Dr.A.Govindarajan*	*SRMIST*	govindarajan.a@ktr.srmuniv.ac.in	5	*Dr.Sundarammalkesavan*	*SRMIST*	*sundarammal.k@ktr@srmuniv.ac.in*

Template 6: Course Learning Syllabus

Course Learning Syllabus (// includes Learning Outcomes & Learning Plan & Assessment Plan)

Course Code	18MAB303T	Course Name	BIO STATISTICS FOR BIOTECHNOLOGISTS	Course Category	B	Basic Sciences	L	T	P	C
							3	1	0	4

Pre-requisite Courses	18MAB102T	Co-requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Mathematics	Data Book / Codes/Standards		Statistical tables	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLR-1 :	*To gain knowledge in measures of central tendency, dispersion, Skewness and moments in Biotechnology.*																		
CLR-2 :	*To appropriately choose, define and / or derive probability distributions such as Binomial, Poisson and Normal distributions to solve biology related problems.*																		
CLR-3 :	*To learn how to formulate and test the hypothesis of single means and difference of means for large samples and to understand and apply Chi-square test for goodness of fit and independence of attributes in Biological topics.*																		
CLR-4 :	*To learn to formulate and test the hypothesis about means, variances for small samples using t and F test and to have knowledge in ANOVA in Biology related topics.*																		
CLR-5 :	*To gain knowledge in correlation and regression lines and also get expose to Non- Parametric tests in Biology.*																		
CLR- 6	*Assess problems and determine the appropriate method to solve problems in application areas of Biotechnology*																		
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																		
CLO-1 :	*Understand solve numerical problems in measures of central tendency and dispersion.*	3	85	80	M	H	L						M	L		H			
CLO-2 :	*Solving problems related to probability distributions applicable to bio technologists.*	3	85	80	M	H		M	M				M			H			
CLO-3 :	*Evaluate the given problems relating to large sample test of mean and difference of mean and Chi-square tests.*	3	85	80	M	H							M			H			
CLO-4 :	*Choose and solve problems with t test, F test and ANOVA.*	3	85	80	M	H		M					M	L		H			
CLO-5 :	*Evaluate problems on concepts of correlation, regression and non parametric tests.*	3	85	80	M	H	L						M			H			
CLO-6 :	*The learners will be able to mathematically formulate and solve numerical problems related to Biotechnogy.*	3	85	80	M	H							M			H			

		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
Duration (hour)		12	12	12	12	12
S-1	SLO-1	Introduction to discrete types of statistical data	Introduction to probability concepts, Random experiment, Trail, Sample space, Sample size, Events(only definitions, properties without proof and simple problems)	Sampling Theory - Basic concepts	Introduction to small sample test	Introduction to Correlation and Regression
	SLO-2	Introduction to continuous types of statistical data	Problems on Probability related to biological applications.	Population, Sample, Sampling distribution, population parameters and sample statistic	small sample tests based on t- distribution for single mean	Karl Pearson's coefficient of correlations
S-2	SLO-1	Measures of central tendency – Introduction to Arithmetic mean, median, Mode	Types of Events: Impossible, Simple, Mutually Exclusive and Independent events(only definitions, properties without proof)	Testing of hypothesis, Null and Alternate hypothesis, Single tailed and two tailed tests, Type- I and Type –II errors	Problems on t-test for single mean	Problems on Karl Pearson's coefficient of correlations
	SLO-2	Problems in Arithmetic mean	Simple problems	Acceptance and Rejection Regions, Level of Significance, Degrees of freedom and Confidence limits	Small sample tests based on t- distribution for difference of means	Spearman's rank correlation coefficient problems
S-3	SLO-1	Problems in median	Problems based on Addition and Multiplication Theorems	Large sample tests based on normal distribution (Z - test)	Problems on t- distribution for difference of means	Spearman's rank correlation coefficient problems
	SLO-2	Problems in mode	Baye's Theorem (without proof) and its applications	Z-Test for single proportion and difference of proportions and problems	Paired t-test	Regression lines and its applications
S-4	SLO-1	Problem solving using tutorial sheet 1	Problem solving using tutorial sheet 4	Problem solving using tutorial sheet 7	Problem solving using tutorial sheet 10	Problem solving using tutorial sheet 13

	SLO-2	Problem solving using tutorial sheet 1	Problem solving using tutorial sheet 4	Problem solving using tutorial sheet 7	Problem solving using tutorial sheet 10	Problem solving using tutorial sheet 13
S-5	SLO-1	Measures of dispersion, Range , Quartile deviation	Introduction to one dimensional random variables	Z-Test for single mean	Problems on Paired t-test	Problems related to Regression lines.
	SLO-2	Mean deviation	Discrete Random variable, Probability mass function , Distribution function, Properties (without proof), Applications	Problems on Z-Test for single mean	F-test for equality of variances	Non-parametric tests - The sign test
S-6	SLO-1	Standard deviation and Co-efficient of variation	Continuous Random variable, Probability density function , Distribution function, Properties (without proof), Applications	Z-Test for difference of means	Problems on F-test for equality of variances	The sign test additional problems
	SLO-2	Problems on Standard deviation and Co-efficient of variation	Simple problems on discrete random variables and continuous random variables	Problems on Z-Test for difference of means	Problems on F-test for equality of variances	The Wilcoxon rank sum test or The Man Whitney U test problems
S-7	SLO-1	Karl Pearson's coefficient of Skewness	Mathematical Expectation	Introduction to Chi- square test	Introduction to Analysis of Variance (ANOVA)	The Wilcoxon rank sum test or The Man Whitney U test problems
	SLO-2	Problems on coefficient of Skewness	Variance, Properties (without proof), Application related problems	Chi -square test for goodness of fit	Problems on ANOVA –One -way classifications	The Kruskal Walis test problems
S-8	SLO-1	Problem solving using tutorial sheet 2	Problem solving using tutorial sheet 5	Problem solving using tutorial sheet 8	Problem solving using tutorial sheet 11	Problem solving using tutorial sheet 14
	SLO-2	Problem solving using tutorial sheet 2	Problem solving using tutorial sheet 5	Problem solving using tutorial sheet 8	Problem solving using tutorial sheet 11	Problem solving using tutorial sheet 14
S-9	SLO-1	Introduction to moments	Binomial distribution, Application to population Genetics	Problems on Chi -square test for goodness of fit	Problems on ANOVA –One -way classifications	The Kruskal Walis test problems
	SLO-2	Raw and Central moments problems	Simple problems on Binomial distribution	Chi -square test for Independence of attributes – Problems formulations	Problems on ANOVA –One -way classifications	The Kruskal Walis test problems
S-10	SLO-1	Moments about the point x=a problems.	Poisson Distribution, Application to population Genetics	Chi -square test for Independence of attributes using contingency table	ANOVA –Two -way classifications	The Wilcoxon signed ranked test problems
	SLO-2	Additional problems on moments	Normal Distribution, Application to population Genetics	Problems on Chi -square test for Independence of attributes using contingency table	Applications of ANOVA –Two –way classification problems.	The Wilcoxon signed ranked test problems
S-11	SLO-1	Problems on finding central moments given moments about a point	Problems on Poisson and Normal distribution	Additional problems on Chi-square test	ANOVA –Two –way classification problems.	Additional problems on all the non parametric tests
	SLO-2	Additional problems on finding central moments	Additional problems on Normal distribution.	Problems on Chi-square test.	ANOVA –Two –way classification problems	Additional problems on all the non parametric tests
S-12	SLO-1	Problem solving using tutorial sheet 3	Problem solving using tutorial sheet 6	Problem solving using tutorial sheet 9	Problem solving using tutorial sheet 12	Problem solving using tutorial sheet 15
	SLO-2	Engineering applications of Measures of central tendency and dispersion	Application of distributions in Engineering	Engineering applications of sampling techniques	Applications of ANOVA in engineering fields	Engineering Applications of Correlation, Regression and Non-parametric methods
Learning Resources		1. Myra L. Samuels, Jeffery A. Witner, Andrew schaffner, Statistics for the Life Sciences, Pearson, Fifth Edition, 2015. 2. Bernard Rosner, Fundamentals of Biostatistics, Brooks/core, Seventh edition, 2011. 3. B K Mahajan, Methods in Bio-statistics for Medical students and Research workers, Seventh Edition, 2010. 4. K. Kalyanaraman, Hareesh N.Ramanathan, P. N. Harikumar,Statistical methods for Research A step by step Approach Using IBM SPSS, Atlantic, First Edition, 2016. 5. Fundamentals of Mathematical Statistics Tenth Edition by Gupta & Kapoor, Sultan Chand & Sons, 2017.				

	Level of Thinking	Continuous Assessment				Final Examination (50%)
		CA – 1 (10%)	CA – 2 (15%)	CA – 3 (15%)	CA – 4 (10%) #	
Level 1	Remember	40 %	30 %	30 %	30 %	30 %
	Understand					
Level 2	Apply	40 %	40 %	40 %	40 %	40 %
	Analyze					
Level 3	Evaluate	20 %	30 %	30 %	30 %	30 %
	Create					

CA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,
SLO – Session Learning Outcome

Course Designers							
(a) Experts from Industry							
1	Mr.V.Maheshwaran	CTS, Chennai	maheshwaranv@yahoo.com				
(b) Experts from Higher Technical Institutions							
2	Dr.K.C.Sivakumar	IIT, Madras	kcskumar@iitm.ac.in	3	Dr.Nanjundan	Bangalore University	nanzundan@gmail.com
(b) Internal Experts							
4	Dr.A.Govindarajan	SRMIST	govindarajan.a@ktr.srmuniv.ac.in	5	Dr.Srinivasan	SRMIST	srinivasan.va@srmuniv.ac.in

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MOVE UP through international alliances and collaborative initiatives to achieve global excellence.
ACCOMPLISH A PROCESS to advance knowledge in a rigorous academic and research environment.

ATTRACT AND BUILD PEOPLE in a rewarding and inspiring environment by fostering freedom, empowerment, creativity and innovation.