# M. Sc (Mathematics)

## <u>III – Semester</u>

	ame of the Department: M ourse Name	Differential Geometr			1	L		T	•		1	Р
	ourse Code	MT504	т <b>у п</b>			3		1	-			0
-	pe of Course (use tick ma		Core ( )	DSE ()	AE	-	SI	EC(0)	•	0	E ()	
	e-requisite	<b>B. Sc.</b> with Mathematics	6 . Frequency (use tick marks)	Even ()	-	( <b>√</b> )		V	Sem (		very S	Sem
7. To	tal Number of Lectures, T	L Futorials, Practical										
	res = 30		Tutorials = 10	I	Practi	cal = ]	Nil					
8. COI	URSE OBJECTIVES: 1. 7	This is an introductory	course on Differentiabl	e manifold	s. The	e aim o	of this	cour	se is t	o intro	oduce	e and
	p basic theoretical concepts											
	course is aimed to provid	e	the affine connections,	curvature	tensoi	s, line	ear co	nnexi	on, N	ijenhı	uis te	nsor
	variant & covariant almost a course is aimed to provide	-	variant and CP subman	ifalds of di	ffaran	tiabla	moni	folds				
	RSE OUTCOMES (CO):	the concept of semi-my	anani anu CK-suoman		neren	liable	mann	ioius.				
	e successful course comple	tion, learners will deve	lop following attribute	s:								
COURS	SE OUTCOME ATTRIBU	JTES										
	CO1 Understand	d the concept of various	kinds of almost contac	t manifold:	s with	exam	ples.					
		fine almost complex ma	anifolds and calculate t	he curvatu	e tens	sors, N	Jijenh	uis te	nsor,	contra	ivaria	int &
	covariant a	lmost analytic vectors.										
		cal arguments on Kahler										
	COA	ze Almost contact mani		- 1		an mai	nitold	, k-co	ntact	Riema	annia	n
	manifolds	and find semi-invariant				0.1.1	1		11 0			
	CO5 -	e understanding of the	-			tolds,	subm	anito	lds of	almos	st	
10 IL.		anifold, almost Grayan	submanifold, F-structu	re manifold	15.							
Unit-1	it wise detailed content	ber of lectures = 08	Title of the unit:	Tensor A	nalvsi	6						
	contact manifold, affinely a						struc	tures.				
Unit-2		ber of lectures =08	Title of the unit:									
	complex manifold, Nijenhu						ion li	near o	conne	xion		
Unit-3	-	ber of lectures = 08	Title of the unit:	•			1011, 11	ineur (		iioii.		
	k nearly Kahler manifolds,					lerian	manit	folds.				
Unit-4	•	ber of lectures = 08	Title of the unit:									
Sasakian	n manifold, quasi Sasakian i	manifold, k-contact Rie	mannian manifold, sem	i-invariant	subm	anifol	ds of a	Sasak	ian m	anifol	d.	
Unit-5		ber of lectures = 08										
Almost I	Hermite manifolds, subman							e man	ifolds			
11. CO-	PO mapping											
COs		Attributes			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO
CO1	Understand the concept examples.	of various kinds of	almost contact mani	folds with	3	1	1	1	2	1	1	3
CO2	Able to define almost of Nijenhuis tensor, contrav			are tensors	3	1	2	1	3	1	2	3
CO3	Make logical argument submanifolds of Kahleria		ly Kahler manifolds	and CR-	3	1	2	1	3	1	1	2
CO4	Characterize Almost cont manifold, k-contact Riem of Sasakian manifolds.				3	1	1	1	2	1	2	3

CO5	Develop the understanding of the basic concepts of Almost Hermite manifolds, submanifolds of almost Hermite manifold, almost Grayan submanifold, F-structure manifolds.	3	1	1	1	2	1	1	2
	3 Strong contribution, 2 Average contribution, 1 Low con	ntribut	ion		1				
12. Bri	ef description of self learning / E-learning component								
1. <u>htt</u>	ps://www.youtube.com/watch?v=klks723on3k								
2. <u>htt</u>	ps://www.youtube.com/watch?v=klks723on3k								
3. <u>http</u>	ps://www.youtube.com/watch?v=KwHfz5BegoU								
13. Boo	oks recommended:								
1. I	David E. Blair, Contact manifolds in Riemannian Geometry, Springer-Verlag. Struct	ures o	f man	ifolds	з,				
2. F	K. Yano & M. Kon, Structures of manifolds World Scientific Publishing Co. Pvt. Ltd	1.							
3. 5	S.I. Hussain. Lecture notes on differentiable manifolds								
4. F	3.Y. Chen, Geometry of Submanifolds, Marcel Dekker, New York.								

2. Course Name	APPLIED FUN	CTIONAL ANALYSIS		L	Т	Р
3. Course Code	MT505			3	1	0
4. Type of Course (u	ise tick mark)	Core (✓)	<b>DE</b> ()	FC ()		<b>OE</b> ()
5. Pre-requisite (if any)	B.Sc.	6. Frequency (use tick	Even ()	Odd (✓)		Every Sem (
7. Total Number of	Lectures, Tutorials					
Lectures = 30		Tutorials = 10		Practical = Ni	1	

8. COURSE OBJECTIVES: The course gives an introduction to Applied functional analysis, which is a branch of analysis in which one develops analysis in infinite dimensional vector spaces. The central concepts which are studied are normed spaces with emphasis on Banach and Hilbert spaces, and continuous linear maps (often called operators) between such spaces. After successfully completion of course, the student will able to explore subject into their respective dimensions.

#### 9. COURSE OUTCOMES (CO):

#### After the successful course completion, learners will develop following attributes:

COURSE OUTCOME	ATTRIBUTES
CO1	Define and describe Metric spaces, examples of metric spaces, interior point, limit point, open set, closed set, neighborhood, convergence, Cauchy sequence, continuity, complete metric spaces, compact metric spaces.
CO2	Define and describe Normed linear Space, Banach spaces, incomplete normed spaces, finite dimensional normed spaces and subspaces, equivalent norms, compactness, Riesz's lemma, linear operators, bounded and continuous linear operators, continuity of linear operators, linear functional, linear operators and functional on finite dimensional spaces.
CO3	Define and describe Inner product spaces, Hilbert spaces, properties of Inner product spaces, polarization identity, orthogonal complements and direct sums, orthogonal sets and sequences, series related to orthogonal sequences and sets, representation of functional on Hilbert space.
CO4	Describe Zorn's lemma, Hahn–Banach theorem, Hahn Banach theorem for complex vector spaces and normed spaces, Application to bounded linear functionals on $C[a, b]$ , uniform boundedness theorem, Open mappings, open mapping theorem, Closed linear operators, closed graph theorem.
CO5	Define and describe Contraction mappings, Picard's iterates, Banach fixed point theorem, Application of Banach theorem to linear equations, Application of Banach theorem to differential equations.
10. Unit wise detailed co	ontent
Unit-1	Number of lectures = 07 Title of the unit: Metric Spaces
1 · 1	f metric spaces, interior point, limit point, open set, closed set, neighborhood, convergence, Cauchy sequence,
	c spaces, compact metric spaces.
Unit-2	Number of lectures =08 Title of the unit: Normed Spaces & Banach spaces

Normed linear Space, Banach spaces, incomplete normed spaces, finite dimensional normed spaces and subspaces, equivalent norms, compactness, Riesz's lemma, linear operators, bounded and continuous linear operators, continuity of linear operators, linear functional, linear operators and functional on finite dimensional spaces.

Unit-3Number of lectures = 08Title of the unit: Inner Product spaces & Hilbert SpacesInner product spaces, Hilbert spaces, properties of Inner product spaces, polarization identity, orthogonal complements and direct sums, orthogonal sets and sequences, series related to orthogonal sequences and sets, representation of functional on Hilbert space.

Unit-5 Number of lectures = 08 Title of the unit: Banach fixed point theorem

Contraction mappings, Picard's iterates, Banach fixed point theorem, Application of Banach theorem to linear equations, Application of Banach theorem to differential equations

#### 11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	<b>PO4</b>	PO5	PO6	PO7	PO8
CO1	Define and describe Metric spaces, examples of metric spaces, interior point, limit point, open set, closed set, neighborhood, convergence, Cauchy sequence, continuity, complete metric spaces, compact metric spaces.		1	1	1	2	2	2	3
CO2	Define and describe Normed linear Space, Banach spaces, incomplete normed spaces, finite dimensional normed spaces and subspaces, equivalent norms, compactness, Riesz's lemma, linear operators, bounded and continuous.		1	1	1	2	1	2	3
CO3	Define and describe Inner product spaces, Hilbert spaces, properties of Inner product spaces, polarization identity, orthogonal complements and direct sums, orthogonal sets and sequences, series related to orthogonal sequences and sets, representation of functional on Hilbert space.		1	1	1	2	1	2	3
CO4	Describe Zorn's lemma, Hahn–Banach theorem, Hahn Banach theorem for complex vector spaces and normed spaces, Application to bounded linear functionals on $C[a, b]$ , uniform boundedness theorem, Open mappings, open mapping theorem, Closed linear operators, closed graph theorem.		1	2	1	1	1	2	3
CO5	Define and describe Contraction mappings, Picard's iterates, Banach fixed point theorem, Application of Banach theorem to linear equations, Application of Banach theorem to differential equations.		1	1	1	2	1	2	3
	3 Strong contribution, 2 Average contribution, 1 Low	contrib	ution						· · · · ·
	rief description of self learning / E-learning component								
	s://nptel.ac.in/courses/111105037/								
	s://www.youtube.com/watch?v=7IIw_U8rv4Q s://freevideolectures.com/course/3145/functional-analysis								
5. <u>mup</u>	s.// incondenies.com/course/5145/functional-analysis								
<b>13.</b> B	ooks recommended:								

1. Introductory Functional Analysis with Applications by Erwin Kreyszig(1989).

2. Introduction to Functional Analysis with Applications by A.H. Siddiqui, Khalil Ahmad and P. Manchanda, Real World Education Publishers, New Delhi(2015).

3. Applied Functional Analysis by A.H. Siddiqui, Real World Education Publishers, New Delhi (2015).

4. Elements of the Theory of Functions and Functional Analysis by W. Rudin.

2. Course Name		INTEGRAL EQ	QUATIONS		L			Т			Р	
3. Course Code		MT506			3			1			0	
4. Type of Course (use	e tick m	ark)	Core (✓)	DE ()	FC ()	)				OE	0	
5. Pre-requisite (if any)		B.Sc.	6. Frequency (use tick marks)	Even ()	Odd	<b>(</b> ✓)				Ever	ry Sen	n ()
7. Total Number of Le	ectures,	Tutorials				1						
Lectures = 30			Tutorials = 10		Practi							
			o develop the skills in mat			ning th	em in	to suc	cessfu	l scie	nce	
•			ools for specialized studie	es in science	e field.							
. COURSE OUTCOME			ill develop following attri	ihutos.								
COURSE OUTCOME	-			ioutes.								
CO1	-		ots of integral operator and	1 functional								
01		_				E			C		1	
CO2	homoge	eneous and inhom	-									
CO3	calculu	s of variations.	lge of Green's functions, I			rra int	egral	equation	ons an	nd of t	he	
CO4	Ordina	ry and partial diffe	erential equations using G	freen's func	tions.							
CO5	They ap	pply different met	thods to solve Integral Equ	uations.								
10. Unit wise detailed co	ontent											
Unit-1	Numb	er of lectures = 0	)7 Title of the unit:	: Metric Sp	oaces							
egularity conditions, spe	anial luin		*									
-o,, spr	ecial kii	nds of kernels, E	igen values and Eigen f	functions, C	Convolut	tion ir	itegral	l, redu	ction	to a	system	mo
lgebraic equations, Free	dholm a	lternative, an app	igen values and Eigen f proximate method, exan									
lgebraic equations, Free esults about the resolvent	dholm a Kernel,	lternative, an app Examples.	proximate method , exan	nples, iterat	tive sch	eme,	Volter	ra inte				
lgebraic equations , Free esults about the resolvent Unit-2	dholm a Kernel, Numb	lternative, an app Examples. er of lectures =0	proximate method , exan 8 Title of the unit:	nples, iterat	tive sch	eme,	Volter	ra inte				
lgebraic equations , Free esults about the resolvent Unit-2	dholm a Kernel, Numb	lternative, an app Examples. er of lectures =0	proximate method , exan 8 Title of the unit:	nples, iterat	tive sch	eme,	Volter	ra inte				
lgebraic equations , Free esults about the resolvent Unit-2 The method of solution of Unit-3	dholm a Kernel, <b>Numb</b> Fredhol	Iternative, an app Examples. <b>or of lectures =0</b> Im, Fredholm first <b>or of lectures = 0</b>	proximate method , exam         8       Title of the unit:         t theory, Examples.         08       Title of the unit:	nples, iterat	tive sch Spaces duct spa	eme, & Bar aces &	Volter nach s à Hilb	ra into paces ert Sp	egral	equati	ion, S	Som
lgebraic equations , Free esults about the resolvent Unit-2 The method of solution of Unit-3 nitial value problems, bo	dholm a Kernel, <b>Numb</b> Fredhol <b>Numb</b> Dundary	lternative, an app Examples. er of lectures =0 m, Fredholm first er of lectures = 0 value problems,	8       Title of the unit:         t theory, Examples.         08       Title of the unit:         Dirac delta Function, Gringer	nples, iterat	tive sch Spaces duct spa	eme, & Bar aces &	Volter nach s à Hilb	ra into paces ert Sp	egral	equati	ion, S	Som
lgebraic equations , Free esults about the resolvent Unit-2 The method of solution of Unit-3 nitial value problems, bo rdinary differential equation	dholm a Kernel, <b>Numb</b> Fredhol <b>Numb</b> oundary ions, Mo	Iternative, an app Examples. er of lectures =0 m, Fredholm first er of lectures = 0 value problems, odified Green's fu	8Title of the unit:8Title of the unit:t theory, Examples.08Title of the unit:Dirac delta Function, Grunction, Examples.	nples, iterat Normed Inner Pro reen's Func	tive sch Spaces duct spa ction ap	eme, <sup>7</sup> & Bar aces & proach	Volter nach s z Hilb n, Gre	paces paces pert Sp pen's f	egral paces unctio	equation on for	nth o	Som
lgebraic equations , Free esults about the resolvent Unit-2 The method of solution of Unit-3 nitial value problems, bo rdinary differential equati Unit-4	dholm a Kernel, <b>Numb</b> Fredhol Dundary ions, Mo	Iternative, an app Examples. er of lectures =0 m, Fredholm first value problems, odified Green's fu er of lectures = 0	Proximate method , examples8Title of the unit:t theory, Examples.08Title of the unit:Dirac delta Function, Grunction, Examples.09Title of the unit:	nples, iterat Normed : Inner Pro reen's Func Fundame	tive sch Spaces duct spa ction ap	eme, & Ban aces & proach eorem	Volter nach s z Hilb n, Gre	ra inte paces pert Sp en's f	egral paces unctio d and	equation for	nth o	orde
lgebraic equations , Free esults about the resolvent Unit-2 The method of solution of Unit-3 nitial value problems, boordinary differential equation Unit-4 ntroduction, Fundamental	dholm a Kernel, Numb Fredhol Dundary ions, Mo Numb l proper	Iternative, an app Examples. er of lectures =0 Im, Fredholm first er of lectures = 0 value problems, odified Green's fu er of lectures = 0 ties of Eigen value	<ul> <li>8 Title of the unit:</li> <li>8 Title of the unit:</li> <li>t theory, Examples.</li> <li>08 Title of the unit:</li> <li>Dirac delta Function, Grunction, Examples.</li> <li>09 Title of the unit:</li> <li>ues and Eigen functions</li> </ul>	nples, iterat Normed : Inner Pro reen's Func Fundame for symmet	tive sch Spaces duct spa ction ap mtal Th cric Kern	eme, <b>&amp; Ban</b> & Ban aces & proach eorem nels, E	Volter nach s ż Hilb n, Gre s of N Expans	ra inte paces ert Sp en's f Norme sion in	egral paces unctio d and Eige	equation on for l <b>Bana</b> n fun	nth of ach	orde
lgebraic equations , Free esults about the resolvent Unit-2 The method of solution of Unit-3 nitial value problems, bo rdinary differential equati Unit-4 ntroduction, Fundamental Bilinear forms, Hilbert-Scl	dholm a Kernel, Numb Fredhol Dundary ions, Mo Numb I proper hmidt th	Iternative, an app Examples. er of lectures =0 m, Fredholm first value problems, odified Green's fu er of lectures = 0 ties of Eigen value eorem and some i	8Title of the unit:8Title of the unit:t theory, Examples.08Title of the unit:Dirac delta Function, Grunction, Examples.09Title of the unit:ues and Eigen functionsimmediate consequences,	nples, iterat Normed Inner Pro reen's Func Fundame for symmet solutions o	tive sch Spaces duct spa ction ap ntal Th ric Kern f a symm	eme, & Bar aces & proach eorem nels, E netric	Volter nach s z Hilb n, Gre ns of N Expansi integr	ra inte paces ert Sp en's f Norme sion in	egral paces unctio d and Eige	equation on for l <b>Bana</b> n fun	nth of ach	orde
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lgebraic equations , Free esults about the resolvent Unit-2 he method of solution of Unit-3 nitial value problems, bound rdinary differential equation Unit-4 ntroduction, Fundamental ilinear forms, Hilbert-Sch Unit-5 bel's Equations, Inversion ifferential equations with fethod. 1. CO-PO mapping COs	dholm a Kernel, Predhol Numb oundary ions, Mo Numb l proper hmidt th Numt on form h convo	Iternative, an app Examples. <b>Per of lectures =0</b> Im, Fredholm first <b>Per of lectures = 0</b> value problems, odified Green's fu <b>Per of lectures = 0</b> ties of Eigen value <b>Per of lectures = 0</b> ula for singular i lution type Kerne <b>Attribute</b>	8       Title of the unit:         8       Title of the unit:         t theory, Examples.       Dirac delta Function, Gunction, Examples.         09       Title of the unit:         ues and Eigen functions immediate consequences,       Dimmediate consequences,         08       Title of the unit:         ntegral equations, Laplacels, Abel's Integral equations       Abel's Integral equations	nples, iterat Normed Inner Pro reen's Func Fundame for symmet solutions o Banach fi ce transform	tive sch Spaces duct spaces duct spaces ction apprint mtal Th ric Kern f a symmity xed point h, Appli ier Tran	eme, & Bar aces & proach proach nels, E netric nt the cation asform	Volter nach s integr to Vo , Solu	ra inte paces ert Sp en's f Norme sion in cal equ olterra ntion b	egral paces unctio d and Eige ation, integ by For PO5	equation on for Bana I Bana Exan Exan ral ar urier	nth of ach etions nples. nd intr Trans	orde an forr
lgebraic equations , Free esults about the resolvent Unit-2 The method of solution of Unit-3 nitial value problems, bound rdinary differential equation Unit-4 ntroduction, Fundamental Bilinear forms, Hilbert-Sch Unit-5 Ibel's Equations, Inversion ifferential equations with fethod. 1. CO-PO mapping COS CO1 Familiar with the con	dholm a Kernel, Numb Fredhol Oundary ions, Mo Numb l proper hmidt th Numt on form h convo	Iternative, an app Examples. <b>Set of lectures =0</b> Im, Fredholm first <b>Set of lectures = 0</b> value problems, odified Green's fur- <b>Set of lectures = 0</b> ties of Eigen value eorem and some in <b>Set of lectures = 0</b> ula for singular in lution type Kernon <b>Attribut</b> of integral operator	8       Title of the unit:         8       Title of the unit:         t theory, Examples.       08         08       Title of the unit:         Dirac delta Function, Grunction, Examples.       09         09       Title of the unit:         ues and Eigen functions       100         immediate consequences,       08         08       Title of the unit:         ntegral equations, Laplace       els, Abel's Integral equa         es       07         or and functional.       08	nples, iterat Normed Inner Pro reen's Func For symmet solutions o Banach fi te transform tions, Four	tive sch Spaces duct spaces otion appresent mtal The ric Kern f a symmetric Kern	eme, & Bar aces & proach proach nels, E netric nt the cation asform	Volter nach s z Hilb h, Gre s of N Expans integr to Ve , Solu	ra inte paces ert Sp en's f Norme sion in al equ olterra	egral paces unctio d and Eige ation, integ by For	equation on for Bana I Bana Exan Exan Exan I aru	nth of ach of a choice of a	orde
lgebraic equations , Free esults about the resolvent Unit-2 The method of solution of Unit-3 nitial value problems, bordinary differential equation Unit-4 ntroduction, Fundamental Bilinear forms, Hilbert-Sch Unit-5 sbel's Equations, Inversion ifferential equations with Method. 1. CO-PO mapping COS CO1 Familiar with the con	dholm a Kernel, Numb Fredhol Oundary ions, Mo Numb I proper hmidt th Numt on form h convo	Iternative, an app Examples. <b>or of lectures =0</b> Im, Fredholm first <b>or of lectures = 0</b> value problems, odified Green's fu <b>or of lectures = 0</b> ties of Eigen value eorem and some if <b>ber of lectures = 0</b> ula for singular i lution type Kerno <u>Attribut</u> of integral operato	8       Title of the unit:         8       Title of the unit:         t theory, Examples.       08         08       Title of the unit:         Dirac delta Function, Grunction, Examples.       09         09       Title of the unit:         ues and Eigen functions       100         immediate consequences,       08         08       Title of the unit:         ntegral equations, Laplace       101         es       101         or and functional.       101	nples, iterat Normed Inner Pro reen's Func For symmet solutions o Banach fi te transform tions, Four	tive sch Spaces duct spaces duct spaces ction apprint mtal Th ric Kern f a symmity xed point h, Appli ier Tran	eme, & Bar aces & proach proach nels, E netric nt the cation asform	Volter nach s integr to Vo , Solu	ra inte paces ert Sp en's f Norme sion in cal equ olterra ntion b	egral paces unctio d and Eige ation, integ by For PO5	equation on for Bana I Bana Exan Exan ral ar urier	nth of ach etions nples. nd intr Trans	orde
Igebraic equations , Free esults about the resolvent Unit-2 The method of solution of Unit-3 nitial value problems, bound rdinary differential equation Unit-4 ntroduction, Fundamental Bilinear forms, Hilbert-Sch Unit-5 Ibel's Equations, Inversion ifferential equations with fethod. 1. CO-PO mapping COS CO1 Familiar with the con Recognize difference CO2 kind and Second kin	dholm a Kernel, Numb Fredhol Numb oundary ions, Mo Numb l proper hmidt th Numt on form h convo	Iternative, an app Examples. <b>or of lectures =0</b> Im, Fredholm first <b>or of lectures = 0</b> value problems, odified Green's fun- ties of Eigen value ties of Eigen value ties of Eigen value <b>or of lectures = 0</b> ula for singular i lution type Kerned <b>Attribut</b> of integral operator cen Volterra and F ogeneous and inhu- of Green's function	8       Title of the unit:         8       Title of the unit:         t theory, Examples.       08         08       Title of the unit:         Dirac delta Function, Grunction, Examples.       09         09       Title of the unit:         ues and Eigen functions       100         immediate consequences,       08         08       Title of the unit:         ntegral equations, Laplace       101         es       101         or and functional.       101	nples, iterat Normed Inner Pro reen's Func Fundame for symmet solutions o Banach fi te transform tions, Four	tive sch Spaces duct spaces ction app ntal Th tric Kern f a symm xed poin h, Appli ier Tran PO1 3	eme, & Bar aces & proach netric netric cation asform PO2 2	Volter nach s z Hilb h, Gre is of N Expans integr orem to Vo , Solu PO3 2	ra inte paces ert Sp en's f Norme sion in ral equ olterra ttion b	egral paces unction d and Eige ation, integ by For PO5 1	equation for both for the second seco	nth or ach or ac	orde and egra forr PO3
gebraic equations , Free soults about the resolvent Unit-2 he method of solution of Unit-3 nitial value problems, bound rdinary differential equation Unit-4 ntroduction, Fundamental ilinear forms, Hilbert-Sci Unit-5 bel's Equations, Inversion ifferential equations with fethod. 1. CO-PO mapping COs CO1 Familiar with the con kind and Second kind equations and of the equations and of the	dholm a Kernel, Numb Fredhol Numb oundary ions, Mo Numb l proper hmidt th Numt on form h convo	Iternative, an app Examples. <b>or of lectures =0</b> Im, Fredholm first <b>or of lectures = 0</b> value problems, odified Green's function <b>or of lectures = 0</b> ties of Eigen value ties of Eigen value <b>or of lectures = 0</b> ula for singular in lution type Kerned <b>Attribut</b> of integral operator cen Volterra and F ogeneous and inho- of Green's functions.	8       Title of the unit:         8       Title of the unit:         t theory, Examples.       08         08       Title of the unit:         Dirac delta Function, Grunction, Examples.       09         09       Title of the unit:         ues and Eigen functions       1000000000000000000000000000000000000	nples, iterat Normed Inner Pro reen's Func Fundame for symmet solutions o Banach fi te transform tions, Four	stive sch         Spaces         duct spaces         otion ap         ntal Th         ric Kern         f a symmetric Kern         xed point         n, Appli         ier Trans         PO1         3         2         2	eme, & Bar aces & proach eorem nels, E netric nt the cation asform PO2 2 2 2 2	Volter nach s i Hilb , Gre is of N Expans integr to Va , Solu PO3 2 2 2	ra inte paces ert Sp en's f Norme sion in cal equ olterra ation b PO4 1 1	egral paces unction d and Eige ation, intego py For PO5 1 1 1	equation on for <b>Bana</b> n function Exan ral an urier <b>PO6</b> 3 2 2 2	ion, S nth o ach ctions nples. nd into Trans PO7 1 2 3	borde s and egra forr PO 1 1 3
lgebraic equations , Free esults about the resolvent Unit-2 he method of solution of Unit-3 nitial value problems, bo rdinary differential equation Unit-4 ntroduction, Fundamental filinear forms, Hilbert-Sch Unit-5 bel's Equations, Inversion ifferential equations with fethod. 1. CO-PO mapping COs CO1 Familiar with the co CO2 Recognize difference kind and Second kin CO3 equations and of the	dholm a Kernel, <b>Numb</b> Fredhol <b>Numb</b> oundary ions, Mo <b>Numb</b> l proper hmidt th <b>Numb</b> on form h convo ce betwee nd, hom owledge e calculu	Iternative, an app Examples. <b>Free of lectures =0</b> Im, Fredholm first <b>Free of lectures = 0</b> value problems, odified Green's func- ties of Eigen value eorem and some in <b>Free of lectures = 0</b> ula for singular in lution type Kerned <b>Attribute</b> of integral operator teen Volterra and Frogeneous and inh- of Green's functions. Intial equations us	8       Title of the unit:         8       Title of the unit:         t theory, Examples.       08         08       Title of the unit:         Dirac delta Function, Grunction, Examples.       09         09       Title of the unit:         ues and Eigen functions       1000000000000000000000000000000000000	nples, iterat Normed Inner Pro reen's Func Fundame for symmet solutions o Banach fi te transform tions, Four	tive sch Spaces duct spaces ction approved mtal Th f a symmetric Kern f a symmet	eme, & Bar aces & proach proach nels, E metric cation asform PO2 2 2 2	volter nach s z Hilb h, Gre is of N Expans integr to Vo , Solu PO3 2 2 2	ra inte paces ert Sp en's f Norme sion in ral equ olterra attion b PO4 1 1	egral paces unction d and Eige ation, integ by For <b>PO5</b> 1 1	equation on for <b>Bana</b> n fun Exan tral ar urier <b>PO6</b> 3 2	nth of ach ctions and internation of the ctions and international and the ctions are ctions and the ctions are ctions.	orde an egra forr PO 1

3 Strong contribution, 2 Average contribution, 1 Low contribution
12. Brief description of self learning / E-learning component
1. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/115104096/lec47.pdf
2. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/111107103/lec13.pdf
3. http://hitoshi.berkeley.edu/221A/delta.pdf
4. https://nptel.ac.in/courses/111107103/
https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/111106100/lec11.pdf
13. Books recommended:
1. 1. Numerical Methods for Scientific and Engineering computation by M.K.
2. Jain, S.R.K. Iyengar, R.K. Jain, New Age Int. Ltd., New Delhi.
3. Numerical Methods by P. Kandasamy, S. Chand Publ. New Delhi.
4. Introduction to Numerical Analysis, by S.S. Sastry Prentice Hall Flied
5. S.D. Conte & C.D. Boor, Elementary Numerical Analysis
Lothar Collatz, Numerical treatment of differential equations, Springer Ver. Publications.

2.	Course Name	Optimization Techn	iques		L	Т	Р
3.	Course Code	MT507	-1		2	1	0
4.	Type of Course (use tick		Core (✓)	DE ()	FC ()	-	OE ()
5.	Pre-requisite (if any)		6. Frequency (use tick	Even ()	Odd (🗸 )		Every Sem ()
7.	Total Number of Lectur	es, Tutorials			1 1		
Le	etures = 30	-	Tutorials = 10		Practical = Ni	1	
	COURSE OBJECTIVES miques	: understand the definitio	ons and Formulation	of linear p	rogramming pro	blem and di	fferent optimizatio
. C	OURSE OUTCOMES (C	0):					
	• the successful course con		velop following attri	ibutes:			
CC	URSE OUTCOME (CO)	ATTRIBUTES					
	C01	To understand the dem method, Simplex metho					
	CO2	Able to explain the Var		ng initial b			sportation problem
	02	method.	transportation prob	olem. Solu	tion of assignm	ent problem	n using Hungaria
	CO3		e basic definitions, ce, Graphical metho	Two-perso od, Solutio	n Zero-sum gar n of games by	nes, Pure an linear prog	nd mixed strategy gramming method
		method. Able to understand the Principle of Dominanc <b>Decision Theory:</b> Intro	e basic definitions, ce, Graphical metho duction, Elements of cing: Basic assumption on k-Machines. <b>R</b> eplacement of items	Two-perso od, Solutio decision p ons, Proces eplacemen	n Zero-sum gar n of games by roblem, Types o sing of n-Jobs o <b>t Problems:</b> R	nes, Pure an linear prog f decision m n 2-Machine eplacement	nd mixed strategy gramming method aking environment es, n-Jobs on 3- of items that
	CO3	method. Able to understand the Principle of Dominance Decision Theory: Intro Decision tree. Able to explain Sequence Machines and 2-Jobs deteriorate with time, Re	e basic definitions, ce, Graphical metho duction, Elements of cing: Basic assumption on k-Machines. Ro eplacement of items cy ory Models,Types of nomic order quantit	Two-person od, Solutio S decision p ons, Proces <b>eplacemen</b> that fails su S inventory	n Zero-sum gar n of games by roblem, Types o sing of n-Jobs o <b>t Problems:</b> R uddenly - Individ models, Various	nes, Pure an linear prog f decision m n 2-Machine eplacement lual replacen s inventory c	gramming method aking environmen es, n-Jobs on 3- of items that nent policy and costs, Deterministi
10.	CO3 CO4	method. Able to understand the Principle of Dominance <b>Decision Theory:</b> Intro- Decision tree. Able to explain Sequence Machines and 2-Jobs deteriorate with time, Re Group replacement police Able to explain Inventor inventory models, Econ probabilistic inventory r	e basic definitions, ce, Graphical metho duction, Elements of cing: Basic assumption on k-Machines. Ro eplacement of items cy ory Models,Types of nomic order quantit	Two-person od, Solutio S decision p ons, Proces <b>eplacemen</b> that fails su S inventory	n Zero-sum gar n of games by roblem, Types o sing of n-Jobs o <b>t Problems:</b> R uddenly - Individ models, Various	nes, Pure an linear prog f decision m n 2-Machine eplacement lual replacen s inventory c	nd mixed strategy gramming method aking environmen es, n-Jobs on 3- of items that nent policy and costs, Deterministi
Un	CO3 CO4 CO5 Unit wise detailed conter it-1 Nu	method. Able to understand the Principle of Dominance Decision Theory: Intro- Decision tree. Able to explain Sequence Machines and 2-Jobs deteriorate with time, Re Group replacement police Able to explain Inventor inventory models, Econ probabilistic inventory rest mber of lectures = 08	e basic definitions, ce, Graphical metho duction, Elements of cing: Basic assumption on k-Machines. Re eplacement of items cy ory Models,Types of nomic order quantity models.	Two-person od, Solutio S decision p ons, Process eplacemen that fails su S inventory y, Price br	n Zero-sum gar n of games by roblem, Types o sing of n-Jobs o <b>t Problems:</b> R addenly - Individ models, Various reaks- one, two,	nes, Pure an linear prog f decision m n 2-Machine eplacement lual replacen s inventory c n-price bre	nd mixed strategy gramming method aking environmen es, n-Jobs on 3- of items that nent policy and costs, Deterministi eaks, Single perio
Un Line	CO3 CO4 CO5 Unit wise detailed conter it-1 Nu ar Programming: Linear	method. Able to understand the Principle of Dominance Decision Theory: Intro- Decision tree. Able to explain Sequent Machines and 2-Jobs deteriorate with time, Re Group replacement polition Able to explain Inventor inventory models, Econ probabilistic inventory replacement mber of lectures = 08 programming problem (I	e basic definitions, ce, Graphical metho duction, Elements of cing: Basic assumption on k-Machines. Ro eplacement of items cy ory Models,Types of nomic order quantity nodels. Title of the unit LPP), Formulation of	Two-person od, Solutio S decision p ons, Process eplacemen that fails su S inventory y, Price br	n Zero-sum gar n of games by roblem, Types o sing of n-Jobs o <b>t Problems:</b> R addenly - Individ models, Various reaks- one, two,	nes, Pure an linear prog f decision m n 2-Machine eplacement lual replacen s inventory c n-price bre	nd mixed strategy gramming method aking environmen es, n-Jobs on 3- of items that nent policy and costs, Deterministi eaks, Single perio
Un Line	CO3 CO4 CO5 Unit wise detailed conter it-1 Nu	method. Able to understand the Principle of Dominance Decision Theory: Intro- Decision tree. Able to explain Sequent Machines and 2-Jobs deteriorate with time, Re Group replacement polition Able to explain Inventor inventory models, Econ probabilistic inventory replacement mber of lectures = 08 programming problem (I	e basic definitions, ce, Graphical metho duction, Elements of cing: Basic assumption on k-Machines. Ro eplacement of items cy ory Models,Types of nomic order quantity nodels. Title of the unit LPP), Formulation of	Two-person od, Solutio S decision p ons, Process eplacemen that fails su S inventory y, Price br	n Zero-sum gar n of games by roblem, Types o sing of n-Jobs o <b>t Problems:</b> R addenly - Individ models, Various reaks- one, two,	nes, Pure an linear prog f decision m n 2-Machine eplacement lual replacen s inventory c n-price bre	nd mixed strategy gramming method aking environmen es, n-Jobs on 3- of items that nent policy and costs, Deterministi eaks, Single perio

**Transportation and Assignment Problem:** Various method of finding initial basic feasible solution of transportation problem, Optimality criterion in transportation problem, Variations in transportation problem, Solution of assignment problem using Hungarian method and Variations in assignment problem

Unit-3 Number of lectures = 08 Title of the unit:

Game Theory: Basic definitions, Two-person Zero-sum games, Pure and mixed strategy, Principle of Dominance, Graphical method, Solution of games by linear programming method. **Decision Theory:** Introduction, Elements of decision problem, Types of decision making environment, Decision tree.

Unit-4 Number of lectures = 08 Title of the unit:

Sequencing: Basic assumptions, Processing of n-Jobs on 2-Machines, n-Jobs on 3-Machines and 2-Jobs on k-Machines. Replacement **Problems:** Replacement of items that deteriorate with time, Replacement of items that fails suddenly - Individual replacement policy and Group replacement policy.

Unit-5 Number of lectures = 08 Title of the unit:

**Inventory Models:** Types of inventory models, Various inventory costs, Deterministic inventory models, Economic order quantity, Price breaks- one, two, n-price breaks, Single period probabilistic inventory models.

**11. CO-PO mapping** COs Attributes PO1 PO2 PO3 PO4 PO5 PO6 PO7 To understand the definitions and Formulation of linear programming problem **CO1** (LPP) Graphical method, Simplex method, Big-M method, Two Phase method, 3 3 2 2 2 2 2 Primal & Dual problem. Able to explain the Various method of finding initial basic feasible solution of **CO2** transportation problem, Optimality criterion in transportation problem. 2 3 3 2 2 3 2 Solution of assignment problem using Hungarian method. Able to understand the basic definitions, Two-person Zero-sum games, Pure and mixed strategy, Principle of Dominance, Graphical method, Solution of CO3 games by linear programming method. Decision Theory: Introduction, 2 2 2 2 3 2 3 Elements of decision problem, Types of decision making environment, Decision tree. Able to explain Sequencing: Basic assumptions, Processing of n-Jobs on 2-Machines, n-Jobs on 3-Machines and 2-Jobs on k-Machines. Replacement **CO4** Problems: Replacement of items that deteriorate with time, Replacement 2 3 3 3 2 2 2 of items that fails suddenly - Individual replacement policy and Group replacement policy Able to explain Inventory Models, Types of inventory models, Various inventory costs, Deterministic inventory models, Economic order quantity, **CO5** 2 2 2 2 2 2 3 Price breaks- one, two, n-price breaks, Single period probabilistic inventory models. 3 Strong contribution, 2 Average contribution, 1 Low contribution 12. Brief description of self learning / E-learning component https://www.youtube.com/watch?v=be9e-Q-jC-0 1. https://www.youtube.com/watch?v=bQ5 PPRPjG4 2. https://www.youtube.com/watch?v=jauhoR7w1YM 3.

### 13. Books recommended:

1 H.A. TAHA "Operations Research- An Introduction" Pearson.

2. K.Swarup, P.K.Gupta and A. Manmohan, "Operations Research", S. Chand.

3. Hiller And Liebarman, "Introduction to Operations Research", McGraw Hill Company.

4. J.K.Sharma, "Operations Research ", Pearson.

	1. Nam	e of the Department: Math	ematics and Statistic	s			
2. Cour	rse Name	Fluid Dynamics			L	Т	Р
3. Cou	rse Code	MT508			3	1	0
4. Type	e of Course (1	ise tick mark)	Core (□)	DSE ()	AEC ()	SEC ()	OE ()
5. Pre- (if a	requisite ny)	B. Sc. with Mathematics	6. Frequency (use tick marks)		Odd (□)		
	7. Tota	l Number of Lectures, Tute	orials, Practicals		I		
Lectures		SE OBJECTIVES: Students	Tutorials = 10		Practical =		
COURSI	can develo equations of solve the d 9. COURS After the s	They will understand the ph p the idea of source, sink and of motion under different con ifferential equations of visco SE OUTCOMES (CO): uccessful course completion E (CO) ATTRIBUTES	d doublet and obtain of nditions. Students will ous incompressible flu <i>n, learners will develo</i>	complex potent be able to und id under speci p following at	tials. Also Unders derstand the simila fied boundary cor ttributes:	tand, formulate arity of the fluid	and solve the
	CO1	Develop mathemati	cal understanding of f	luid Dynamics	s problems.		
	CO2		ous concepts and relaviscous fluids and the		nd understand the	physical and n	nathematical
	CO3	Understand and dev	velop the idea of sourc	e, sink and do	ublet and obtain c	omplex potentia	als
	CO4		derive and solve the t rs. Derive and solve the and circulation.				
	CO5	independently. Obta	nal analysis to obtain ain, solve and analyze of concentric rotating l.	Navier-Stoke	equation of motio	n of viscous flu	id between
	10. Unit	wise detailed content					
Unit-1		Number of lectures = 08		the unit:			
	-	of motion - Lagrange's and two-dimensions-Complex ve	-				
Unit-2		Number of lectures =08	Title of	the unit:			
		nsional irrotational motion p orem of Blasius motion of a	•		-	•	
Unit-3		Number of lectures = 08	Title of	the unit:			
Unit-4	Equations	tal Equations of Motion of (equation of Motion, Equ n Theorem). Number of lectures = 08		reamlines & 1			
	-	Similarity (Reynold's Lawns $\pi$ -products and coefficient uations.	•			-	

Steady Motion between parallel plates: Velocity distribution & Temperature Distribution.

Plane Couette flow, generalized plane Couette flow. Flow between two concentric Rotating Cylinders: Velocity distribution & Temperature distribution.

#### 11. CO-PO mapping COs PO2 PO3 **PO5** Attributes **PO1 PO4 PO6** PO7 **PO8** 2 3 2 1 1 1 2 2 fluid Develop mathematical understanding of Dynamics CO1 problems. 3 2 2 2 1 1 1 2 Understand the various concepts and relations of fluid and **CO2** understand the physical and mathematical formulation of non viscous fluids and their solutions. 3 1 1 1 1 2 2 2 Understand and develop the idea of source, sink and doublet and **CO3** obtain complex potentials 3 1 1 1 1 2 2 2 Able to understand, derive and solve the two dimensional equations of fluid motion of circular, elliptic and coaxial **CO4** cylinders. Derive and solve the equation of motion of viscous fluid and obtain the energy equation, vorticity and circulation. 2 2 2 2 3 1 1 1 Apply the dimensional analysis to obtain the dimensionless numbers to express the fluid motion independently. Obtain, solve and analyze Navier-Stoke equation of motion of viscous fluid **CO5** between parallel plates and of concentric rotating cylinders to find the velocity and temperature distribution function of the fluid. 3 Strong contribution, 2 Average contribution, 1 Low contribution 12. Brief description of self learning / E-learning component https://nptel.ac.in/courses/112105171/ 1. 2. http://www3.dicca.unige.it/rrepetto/linked-files/fluid-dynamics-lecture-notes.pdf http://web.engr.uky.edu/~acfd/me330-lctrs.pdf 3. 13. Books recommended: 1.W.H. Besaint and A.S.Ramsay, A Treatise on Hydromechanics, Part-II. CBS Publishers, Delhi, 1988. 2. F. Chorlton, Text book of Fluid Dynamics, CBS Publishers, Delhi, 1985. 3. G.K. Batchelor, An Introduction to Fluid Dynamics, Cambridge University Press (1970). 4. C.S. Yih, Fluid Mechanics, McGraw-Hill Book, Company 5. T. E. Faber, Fluid Dynamics for Physicists, Cambridge University Press. 6. M.D Raisinghania, Fluid Dynamics, S. Chand Publishing 7. Z.U.A. Warsi, Fluid Dynamics, Theoretical and Computational approaches, C.R.C. Press.

1.Name of the Departm	nent: Mathematics and Statistic	28				
2.Course Name	Special Functions			L	Т	Р
3.Course Code	MT509			3	1	0
4.TypeofCourse(usetic)	kmark)	Core(□)	DSE()	AEC()	SEC()	OE()
5.Pre-requisite (ifany)	M.Sc. (Mathematics)	6.Frequency(u setickmar ks)	Even (□)	Odd (Yes)	EitherSem ()	EverySem()
7.TotalNumberofLectu	res,Tutorials,Practicals	1	1	1	1	1
Lectures=30		Tutorials=10		Practical=N	il	

**8. COURSE OBJECTIVES** • The interplay between mathematical analysis and physical understanding. • To investigate and derive the properties of special functions, inter-relations between such functions and their representations in various forms. • Certain specific systems of orthogonal polynomials and their properties.

# 9. COURSE OUTCOMES (CO):

200100010	COME (CO)	ATTRIBUTES									
C01			erpret solutions of many			ortant d	ifferent	tial equ	uations	s by ma	aking
CO2		Derive the formulas a by different methods.	and results of certain cla	assical	special	function	ns and	orthog	gonal p	polyno	mials
CO3		Derive the generating	relations involving spec	ial fun	ctions.						
CO4		Understand purpose ar	nd functions of the gam	ma and	beta fu	nctions,	and Tr	ransfor	matior	1.	
CO5			lge to analyse the pro als, which helps in exp areas of mathematics.								
10.Unit wise detail	led content		-								
Unit-1		er of lectures=08	Title of the unit: Ga								
ContentNumber of lectures 00The of the unit: Gamma and beta functionsThe Euler or Macheroni Constant, Gamma function, A series for gamma function, Difference equation Gamma(Z+1) = ZGammaEuler's Integral for Gamma(z), Beta function, Value of Gamma(z)Gamma(1-z), Factorial function, Legender duplication fGauss multiplication Theorem.Unit-2Number of lectures=08Title of the unit: Hypergemetric and Generalized hypergeometric											
Unit-2	Numb	er of lectures=08	Title of the unit: Hyp function	oergem	etric a	nd Gen	eralize	ed hyp	ergeoi	metric	
Definition and integ	gral representations and its	ntion of Gauss hypergeo solutions, F(a,b;c;z) as	function omteric function 2F1 (a,l	o;c;z).	Contagi	ous fund	ction re	elation,	Hype	rgeom	etric
Definition and integ differential equation	gral representations and its	ntion of Gauss hypergeo solutions, F(a,b;c;z) as	function omteric function 2F1 (a,l	b;c;z). ( ameters	Contagi s, Elen	ous fund nentary	ction re series	elation, manip	Hype	rgeom	etric
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C01	Student will be able to understand special functions of various engineering problem and to known the application of some basic mathematical methods via all these special functions.		1	1		1	1	1	3	
CO2	Students will be able to Use power series to solve second-order differential equations.	3	1	2		3	1	1	3	
CO3	Students will use the gamma function, beta function and special functions to: evaluate different types of integral calculus problems and to solve differential equations.	3	1	2		3	1	1	3	
CO4	Students gain importance of Certain specific systems of orthogonal polynomials and their properties	3	1	1		3	1	1	3	
CO5	Students will gain an understanding of Stability of Special functions with applications	3	1	1		2	2	1	3	
	3 Strong contribution, 2 Average contribution,	1 Low	contrib	ution						
12.Brief	description of selflearning/E-learning component									
1.        https://meet.google.com/apj-ammk-bhp, https://web.mst.edu/~lmhall/SPFNS/spfns.pdf         2.        https://meet.google.com/byc-ckzd-ghr, http://web.math.ku.dk/~henrikp/wosfa/book-of-abstracts.pdf         3.        https://meet.google.com/apj-ammk-bhp										
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