DEPARTMENT OF MATHEMATICS

VISION

Empower students with the core knowledge in Mathematics to become accurate, efficient and flexible problem solvers.

MISSION

Create a passion for pure and applied Mathematics through the techniques of procedural and logical reasoning to enhance Mathematical competence.

M. Sc. MATHEMATICS

Programme Educational Objectives (PEOs)

PEO1: develop an in-depth understanding of concepts, theories and techniques

PEO2: interpret concepts in problem solving

PEO3: augment technical, analytical and teaching skills

PEO4: qualify in competitive exams

PEO5: succeed in academics, research and industry

Programme Specific Outcomes (PSOs)

Upon completion of M.Sc. Mathematics programme, the student will be able to

PSO1: apply the techniques of formal proof and justification in establishing facts through procedural and logical reasoning

PSO2: formulate and analyse mathematical models of real-life applications

PSO3: discover new knowledge to find out solutions of Mathematical problems thereby promoting thirst for research

PSO4: communicate effectively, one's ideas in a clear and concise manner before an expert or lay audience

PSO5: produce and defend an original contribution in the related field of their choice

PSO6: appreciate the beauty of abstract concepts and imbibe the elegance of Mathematics through disciplined study

COURSE PROFILE

M.Sc. Mathematics

From 2021 batch onwards

Sem.	Course Code	Course Title	Course Type	Hrs./Wk.		Credits	Passed in Academic Council	Offered to	Offered by
				TH	LA				
I	PGM1501CM	ALGEBRA I	TH	6		5	BE2020	APMAT	MAT
	PGM1502CM	REAL ANALYSIS	TH	6		5	BE2020	APMAT	MAT
	PGM1402CM	ORDINARY DIFFERENTIAL EQUATIONS	TH	5		4	BE2020	APMAT	MAT
	PGM1505CM	MATHEMATICAL STATISTICS	TH	6		5	BE2020	APMAT	MAT
	PGM1404CM	COMBINATORIAL THEORY	TH	5		4	BG2020	APMAT	MAT
	PGV1001PV	FOUNDATION COURSE ON WOMEN'S STUDIES	TH	2		-	BE2020	NON LDC ALLM	Centre for VE
	PGV1002PV	PERSPECTIVES ON GENDER						LDC ALLM	
	PIV1001PI	THE BIBLE AND SCIENCE						APCH/ SPCH	
		TOTAL		**30**		**23**			
II	PGM2401CM	ALGEBRA II	TH	5		4	BE2020	APMAT	MAT
	PGM2404CM	DIFFERENTIAL GEOMETRY	TH	5		4	BH2021	APMAT	MAT

Sem.	Course Code	Course Title	Course Type	Hrs./Wk.		Credits	Passed in Academic Council	Offered to	Offered by
				TH	LA				
	PGM2405CM	COMPLEX ANALYSIS	TH	5		4	BH2021	APMAT	MAT
	PGM2401MO/ PGM2402MO / PGM2403MO	PARTIAL DIFFERENTIAL EQUATIONS / NUMERICAL ANALYSIS / CLASSICAL MECHANICS	TH	5		4	BE2020	APMAT	MAT
	PGM2301CT	RESEARCH METHODOLOGY	LT	2	2	3	BE2020	APMAT	MAT
	PGM2201EI / PGM2202EI	ANALYTICAL SKILLS FOR COMPETITIVE EXAMINATIONS / DISCRETE MATHEMATICS	TH	4		2	BE2020	ALLM	MAT
	PGV2001PV	HUMAN RIGHTS AND DUTIES	TH	2		-	BE2020	ALLM	Centre for VE
	PGV2002PV	PRACTICING HUMAN RIGHTS							
	PIV2001PI	RIGHTS, RESPONSIBILITIES AND THE BIBLE						APCH/ SPCH	
		TOTAL		**30**		**21**			

PGM1501CM ALGEBRA I

(THEORY)

Class: M.Sc. Mathematics	**Semester**: I	**Hours per week:** 6 hrs./wk.

Cos	**COURSE OUTCOMES**	**COGNITIVE LEVEL**
On successful completion of the course, the student will be able to		
CO1	analyse the properties of groups and prove related results	K4 Analyse
CO2	analyse different concepts to prove related theorems	K4 Analyse
CO3	explain the properties and prove results on solvable groups	K5 Evaluate
CO4	solve problems and prove theorems in Euclidean rings	K6 create
CO5	construct polynomial rings over commutative fields and prove related concepts via theorem	K6 Create

COURSE CONTENT:

UNIT I : GROUPS AND HOMOMORPHISMS **18 hrs.**

Definition of a group – some examples of groups – some preliminary lemmas – subgroups – acounting principle – normal subgroups and quotient groups – homomorphisms – automorphisms.

UNIT II : SYLOW'S THEOREM AND FINITE ABELIAN GROUPS **18 hrs.**

Cayley's theorem – permutation groups – another counting principle – Sylow's theorem– directproduct – finite abelian groups.

UNIT III : SOLVABLE GROUPS **18 hrs.**

Generators of a subgroup and derived subgroups – normal series – solvable groups and JordanHolder theorem.

UNIT IV : RING THEORY **18 hrs.**

Euclidean rings – a particular Euclidean ring.

UNIT V : POLYNOMIAL RINGS **18 hrs.**

Polynomials over the rational field – polynomial rings over commutative rings.

TEXTBOOK(S):

Herstein I.N., (2002). *Topics in algebra*, (2nd ed.), Singapore: Wiley Eastern Limited. Print. (Chapters 2,3(3.7–3.11))

Surjeet Singh & Qazi Zameeruddin, (2001). *Modern algebra*, New Delhi: Vikas Publishing HousePvt. Limited. Print. (Chapter 5)

REFERENCE BOOK(S):

Dummit D. S. & Foote R. M., (2011). *Abstract Algebra*, (3rd ed.), New Jersey: John Wiley &Sons, Inc. Print. Publication

Jacobson, (1953). *Lectures in abstract algebra,* (Vol. I), New Delhi: Narosa Publishing House. Print.

John Fraleigh, (1982). *A first course in abstract algebra*, New Delhi: Narosa Publishing House. Print. Vijay K Khanna& Bhambri S.K., (2018). *A course in abstract algebra,* (5th ed.), New Delhi: Vikas Publishing House Pvt. Ltd. Print.

MAPPING: COs consistency with PSOs

PGM1501CM ALGEBRA I						
CO/PSO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	1	2	2	3	1
CO2	3	1	2	3	2	2
CO3	3	1	2	3	2	2
CO4	3	1	2	2	2	2
CO5	3	1	2	3	2	2

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1), No correlation (0)

PGM1502CM REAL ANALYSIS

(THEORY)

Class: M.Sc. Mathematics	**Semester**: I	**Hours per week:** 5 hrs./wk.

Cos	**COURSE OUTCOMES**	**COGNITIVE LEVEL**
On successful completion of the course, the student will be able to		
CO1	identify the behavior of series and prove results	K3 Apply
CO2	examine and analyse the continuity of functions in different domains	K4 Analyse
CO3	prove theorems on differentiation and solve related problems	K5 Evaluate
CO4	analyse the properties of Riemann – Stieltjes integral and to solve problems	K4 Analyse
CO5	discuss the pointwise and uniform convergence of sequences and series of functions and prove related results via theorems	K6 Create

COURSE CONTENT:

UNIT I : NUMERICAL SERIES **15 hrs.**

Series – series of nonnegative terms – number e – root and ratio tests – power series – summation byparts – absolute convergence – addition and multiplication of series – rearrangements.

UNIT II : CONTINUITY **15 hrs.**

Limits of functions – continuous functions – continuity and compactness – continuity and connectedness –discontinuities – monotonic functions – infinite limits and limits at infinity.

UNIT III : DIFFERENTIATION **15 hrs.**

Derivative of a real function – mean value theorems – continuity of derivatives – L' Hospital's rule – derivatives of higher order – Taylor's theorem – differentiation of vector–valued functions.

UNIT IV : RIEMANN–STIELTJES INTEGRAL **15 hrs.**

Definition and existence of the integral – properties of the integral – integration and differentiation – integration of vector– valued functions.

UNIT V : SEQUENCES AND SERIES OF FUNCTIONS **15 hrs.**

Discussion of main problem – uniform convergence – uniform convergence and continuity – uniform convergence and integration – uniform convergence and differentiation – equicontinuous families of functions – Stone Weierstrass theorem.

TEXTBOOK(S):

Walter Rudin, (2013). *Principles of Mathematical Analysis,* (3rd ed.), New Delhi: McGraw Hill Education (India) Private Limited. Print. (Chapters 3 (3.21 – 3.55), 4,5,6 (up to 6.25), 7)

REFERENCE BOOK(S):

Apostol, (1990). *Mathematical Analysis.* New Delhi: Narosa Publishing House, Print. Karunakaran V., (2012). *Real Analysis*, New Delhi: Dorling Kindersley Pvt. Ltd., Print.

Richard R. Goldberg, (2012). *Methods of Real Analysis*, New Delhi: Oxford & IBH Publishing Co.Pvt. Ltd., Print.

MAPPING: COs consistency with PSOs

PGM1502CM REAL ANALYSIS						
CO/PSO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	1	2	3	2	2
CO2	2	1	3	3	2	2
CO3	2	1	3	3	2	2
CO4	2	1	3	3	2	2
CO5	2	1	3	3	2	2

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1), No correlation (0)

PGM1402CM ORDINARY DIFFERENTIAL EQUATIONS

(THEORY)

Class: M.Sc. Mathematics	**Semester**: I	**Hours per week:** 5 hrs./wk.

Cos	**COURSE OUTCOMES**	**COGNITIVE LEVEL**
On successful completion of the course, the student will be able to		
CO1	solve the first order homogeneous and non-homogeneous differential equations with constant coefficients	K3 Apply
CO2	determine the solutions of second order linear differential equations with constant coefficients	K5 Evaluate
CO3	evaluate the solutions of n^{th} order linear differential equations with constant coefficients and real constants	K5 Evaluate
CO4	solve the first order homogeneous and non-homogeneous differential equations with variablecoefficients	K6 Create
CO5	test the existence and uniqueness of solutions of first order differential equations and solve them using various methods	K6 Create

COURSE CONTENT:

UNIT I : FIRST ORDER LINEAR EQUATIONS WITH CONSTANT COEFFICIENTS 15 hrs.

Differential equations – problems associated with differential equations – linear equations of the first order – equation y' + ay = 0 – equation y' + ay = b(x) – general linear equation of the first order.

UNIT II : SECOND ORDER LINEAR EQUATIONS WITH CONSTANT COEFFICIENT 15 hrs.

Second order homogeneous equations – initial value problems – linear dependence andindependence – a formula for Wronskian – non-homogeneous equation of order two.

UNIT III : HIGHER ORDER LINEAR EQUATIONS WITH CONSTANT COEFFICIENTS 15 hrs.

Homogeneous and non-homogeneous equations of order n – initial value problems for n^{th} orderequations – equations with real constants.

UNIT IV : LINEAR EQUATION WITH VARIABLE COEFFICIENTS 15 hrs.

Initial value problems for the homogeneous equation – solutions of the homogeneous equation – Wronskian and linear independence – reduction of the order of a homogeneous equation – non- homogeneous equation –homogeneous equations with analytic coefficients.

UNIT V : EXISTENCE AND UNIQUENESS OF SOLUTIONS TO FIRST ORDER EQUATIONS 15 hrs.

Equations with variables separated – exact equations – method of successive approximations – Lipschitz condition.0

TEXTBOOK(S):

Earl. A. Coddington, (2003). *An Introduction to Ordinary Differential Equations*, New Delhi: Prentice Hall of India Ltd. Print. (Chapters 1, 2(1 – 10), 3(1 – 7), 5 (1 – 5)).

REFERENCE BOOK(S):

Frank Ayres Jr, (2000). *Differential Equations.* Singapore**:** Schaum outline series, McGraw Hill Company. Print.

Garrett Birkoff& Gian Carlo Rota, (1989). *Ordinary Differential Equation,* (3rd ed.), New York: John Wiley. Print.

MAPPING: COs consistency with PSOs

PGM1402CM ORDINARY DIFFERENTIAL EQUATIONS

CO/PSO	PSO					
	1	2	3	4	5	6
CO1	3	3	2	2	2	3
CO2	3	3	3	3	2	3
CO3	3	3	2	3	3	3
CO4	3	2	2	3	3	2
CO5	2	2	3	3	3	2

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1), No correlation (0)

PGM1505CM MATHEMATICAL STATISTICS

(THEORY)

Class: M.Sc. Mathematics	**Semester**: I	**Hours per week:** 6 hrs./wk.

Cos	**COURSE OUTCOMES**	**COGNITIVE LEVEL**
On successful completion of the course, the student will be able to		
CO1	identify the distribution of a random variable and calculate its expected values and related terms	K2 Understand
CO2	apply the marginal and conditional distributions of two random variables and expectations and variances of random variables to solve problems	K3 Apply
CO3	determine the discrete and continuous probability distributions to solve problems	K5 Evaluate
CO4	Determine the probability density functions, mean and variance of continuous distributions and the distribution function of r^{th} order statistic	K5 Evaluate
CO5	discuss the convergence in probability and in distribution of a random variable with cumulative density function and prove related theorems	K6 Create

COURSE CONTENT:

UNIT I : PROBABILITY AND DISTRIBUTION **18 hrs.**

Random variables – discrete random variables – continuous random variables – transformations – expectation of a random variable – some special expectations – important inequalities.

Self-Study: Problem solving

UNIT II : MULTIVARIATE DISTRIBUTIONS **18 hrs.**

Distributions of two random variables – expectation – transformations: bivariate random variables – conditional distributions and expectations – correlation coefficient – independent random variables – extension to several random variables – transformations for several random variables – linear combinations of random variables.

Self-Study: Problem solving

UNIT III : DISTRIBUTIONS **18 hrs.**

Binomial and related distributions – Poisson distribution – Gamma, Chi-square and Beta distributions – Normal distribution.

Self-Study: Problem solving

UNIT IV : SPECIAL DISTRIBUTIONS AND ORDER STATISTICS **18 hrs.**

t and F distributions – order statistics.

Self-Study: Problem solving

UNIT V : CONSISTENCY AND LIMITING DISTRIBUTIONS **18 hrs**.

Convergence in probability – convergence in distribution.

Self-Study: Problem solving

TEXTBOOK(S):

Robert V. Hogg, Joseph Mckean & Allen T. Craig, (2018). *Introduction to Mathematical Statistics,* (7^{th} ed.), New York: Macmillan Publishing Company. Print. (Chapter 1(32– 69), 2 (75 – 124,128-139), 3 (141 – 180, 191–198), 4 (231 –234, 240, 241), 5 (295 – 305)).

REFERENCE BOOK(S):

John E. Freund, (1998). *Mathematical Statistics*, (6^{th} ed.), New Delhi: Prentice Hall of India PrivateLimited. Print.

Jun Shao., (1999). *Mathematical Statistics,* (2^{nd} ed.), USA: Springer-Verlag. Print.

Parimal Mukhopadhyay, (2016). *Mathematical Statistics*, Kolkata: Books and Allied Pvt. Ltd. Print.

MAPPING: COs consistency with PSOs

PGM1505CM MATHEMATICAL STATISTICS						
CO/PSO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1	2	2	2	2	1
CO2	2	2	2	2	2	1
CO3	2	2	2	2	2	1
CO4	2	2	2	2	2	1
CO5	2	2	2	2	2	1

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1), No correlation (0)

PGM2401CM ALGEBRA II

(THEORY)

Class: M.Sc. Mathematics	**Semester**: I	**Hours per week:** 5 hrs./wk.
Cos	**COURSE OUTCOMES**	**COGNITIVE LEVEL**
On successful completion of the course, the student will be able to		
CO1	interpret the algebraic structure of extension fields and the transcendence of e via theorems	K2 Understand
CO2	analyse the roots of polynomials via theorem	K4 Analyze
CO3	explain the elements of Galois theory and to prove related results	K4 Analyze
CO4	categorize the linear transformations	K4 Analyze
CO5	deduct the properties of linear transformations to prove theorems	K5 Evaluate

COURSE CONTENT:

UNIT I : EXTENSION FIELD **15 hrs.**

Extension fields – transcendence of e.

UNIT II : ROOTS OF POLYNOMIALS **15 hrs.**

Roots of polynomials – more about roots.

UNIT III : GALOIS THEORY **15 hrs.**

The elements of Galois theory.

UNIT IV : LINEAR TRANSFORMATIONS **15 hrs.**

Canonical forms: Triangular form – nilpotent transformations – Jordan and rational canonicalforms.

UNIT V : PROPERTIES OF LINEAR TRANSFORMATIONS **15 hrs.**

Trace and transpose – Hermitian – unitary and normal transformations – real quadratic forms.

TEXTBOOK(S):

Herstein I.N., (2014). *Topics in Algebra,* (2nd ed.), Singapore: John Wiley& Sons. Print. (Chapter: 5 (5.1 – 5.3, 5.5–5.6), 6 (6.4–6.8, 6.10 –6.11)).

REFERENCE BOOK(S):

Jacobson., (1973). *Basic Algebra*, Delhi: Hindustan publishing corporation. Print. Kaplansky., (1969). *Fields and Rings*, Chicago: University of Chicago press. Print.Serge Lange, (1984). *Algebra*, London: Wesley publishers. Print.

Vijay K Khanna, Bhambri S.K., (2018). *A course in abstract algebra,* (5th ed.), New Delhi: VikasPublishing House Pvt. Ltd. Print.

MAPPING: COs consistency with PSOs

PGM2401CM ALGEBRA II						
CO/PSO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	1	2	2	3	1
CO2	3	1	2	3	2	2
CO3	3	1	2	3	2	2
CO4	3	1	2	2	2	2
CO5	3	1	2	3	2	2

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1), No correlation (0)

PGM2404CM DIFFERENTIAL GEOMETRY

(THEORY)

Class: M.Sc. Mathematics	**Semester**: II	**Hours per week:** 5 hrs./wk.

Cos	**COURSE OUTCOMES**	**COGNITIVE LEVEL**
On successful completion of the course, the student will be able to		
CO1	find the curvature and torsion of a curve and prove related results	K1 Understand
CO2	make use of the concepts of developable surfaces, tangent and normal lines to prove related results	K3 Apply
CO3	illustrate results in terms of curvilinear coordinates and fundamental magnitudes	K3 Apply
CO4	develop proofs of different concepts on surfaces	K3 Apply
CO5	prove results on geodesics and solve problems	K5 Evaluate

UNIT I : CURVES WITH TORSION **15 hrs.**

Tangent – principal normal – curvature – binormal – Serret Frenet formulae – locus of centre ofcurvature – spherical curvature – locus of centre of spherical curvature – curve determined by its intrinsic equations – helices – spherical indicatrix of tangent – involutes – evolutes – Bertrand curves.

UNIT II : ENVELOPE, DEVELOPABLE SURFACES **15 hrs.**

Surfaces – tangent plane – normal – envelope – characteristics – edge of regression – developablesurfaces – osculating developable – polar developable – rectifying developable – envelope – characteristic points.

UNIT III : CURVILINEAR COORIDNATES ON A SURFACE, FUNDAMENTAL MAGNITUDES **15 hrs.**

Curvilinear coordinates – first order magnitudes – directions on a surface – normal – second ordermagnitudes – derivatives of n – curvature of normal section – Meunier's theorem.

UNIT IV : CURVES ON A SURFACE **15 hrs.**

Principal directions and curvatures – first and second curvatures – Euler's theorem – surface $z = f(x,y)$ – surface of revolution.

UNIT V : GEODESICS AND GEODESIC PARALLELS **15 hrs.**

Geodesic property – equations of geodesics – surface of revolution – torsion of a geodesic – Bonnet's theorem – Joachimthal's theorem – vector curvature – geodesic curvature.

TEXTBOOK(S):

Weatherburn C.E., (2016). *Differential Geometry of three dimensions Vol. I*, UK: Cambridge University Press. Print. (Chapters 1 to 4(29 – 31, 33 – 34), 6(46 – 55))

REFERENCE BOOK(S):

Gupta, Malik, Pundir S.K., (2015). *Differential Geometry*, Meerut: K.K.Mittal for Prakashan. Print. Mittal S.C., Agarwal D.C., (2010). *Differential Geometry*, (36th ed.), Meerut: Krishna PrakashanMedia (P) Ltd. Print.

Willmore T.J., (2012). *An Introduction to Differential Geometry*, USA: Courier Corporation. Print.

WEBLINK(S):

eBook

Muzammil Tanveer, (2020). Differential Geometry. Retrieved from https://www.mathcity.org/msc/notes/differential-geometry-syed-hassan-waqas. CC BY -NC-SA 4.0 license. Usman Hamid. M., (2019). *Differential Geometry*. Retrieved from https://www.mathcity.org/msc/notes/differential-geometry-m-usman-hamid. CC BY -NC-SA 4.0 license.

Video

NP-TEL. (2014, August 12). *Vector Calculus in Geometry* [Video file]. Retrieved from https://www.youtube.com/watch?v=My_RCvKdHys&t=732s. CC BY license.

MAPPING: COs consistency with PSOs

CO	PSO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	1	1	2	2	2
CO2	2	1	1	2	2	2
CO3	2	1	1	2	2	2
CO4	2	1	1	2	2	2
CO5	2	1	1	2	2	2

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGM2405CM COMPLEX ANALYSIS

(THEORY)

Class: M.Sc. Mathematics	**Semester**: II	**Hours per week:** 5 hrs./wk.

Cos	**COURSE OUTCOMES**	**COGNITIVE LEVEL**
On successful completion of the course, the student will be able to		
CO1	solve problems on complex numbers and functions	K3 Apply
CO2	apply conformal mappings and linear transformations in related areas	K3 Apply
CO3	Evaluate line integrals using standard results on complex integration	K5 Evaluate
CO4	prove results and evaluate definite integrals	K5 Evaluate
CO5	Discuss the behaviour of infinite series and infinite products and prove results	K6 Create

COURSE CONTENT:

UNIT I : COMPLEX NUMBERS AND COMPLEX FUNCTIONS **15 hrs.**

Binomial equation – the spherical representation – limits and continuity – analytic functions – polynomials – rational functions – sequences and series – uniform convergence – power series – Abel's limit theorem.

UNIT II : ANALYTIC FUNCTIONS AS MAPPINGS **15 hrs.**

Arcs and closed curves – analytic functions in regions – conformal mappings – length and area – cross ratio – symmetry – elementary conformal mappings.

UNIT III : COMPLEX INTEGRATION **15 hrs.**

Line integrals – rectifiable curves – line integrals as functions of arcs – Cauchy's theorem for a rectangle – Cauchy's theorem for an open disc – index of a point with respect to a closed curve – Cauchy's integral formula – higher derivatives – Taylor's theorem – local mapping – the maximum principle.

UNIT IV : THE GENERAL FORM OF CAUCHY'S THEOREM AND CALCULUS OF RESIDUES **15hrs.**

Chains and cycles – simple connectivity – homology – general form of Cauchy's theorem (statement only) – harmonic functions – the mean value property – Poisson's formula – Schwarz's theorem.

UNIT V : SERIES AND PRODUCT DEVELOPMENTS **15 hrs.**

Weierstrass's theorem –Taylor series – Laurent series – partial fractions – infinite products – canonical products – Gamma function – Stirling's formula.

TEXTBOOK(S):

Lars V. Ahlfors, (2017). *Complex Analysis*, US: McGraw Hill Book Company, Print. (Chapter:1(sections 2.2 – 2.4),2,3 (sections 2,3,4), 4,5(sections 1,2)).

REFERENCE BOOK(S):

John B Conway, (2012). *Functions of one complex variable*, New York: Springer.Print.

Karunakaran V, (2005). *Complex Analysis,* UK: Alpha Science International Ltd. Print.

Priestley, (2003). *Introduction to Complex Analysis*, New York: Oxford University Press. Print.

Ruel V Churchill & James Ward Brown, (2013). *Complex Variables and Applications*, US: McGraw Hill Education. Print.

WEBLINK(S):

Nptelhrd. (2015, November 18). *Arzela-Ascoli Theorem*. [Video file]. Retrieved from https://youtu.be/zqt7ubXbIe8. CC BY license.

Khan Academy. (2016, August 6*).Laurent Series of Complex Functions*.[Video file]. Retrieved from https://youtu.be/0ZOMkmy-aTo. CC BY license.

MAPPING: COs consistency with PSOs

PGM2405CM COMPLEX ANALYSIS						
CO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1	1	1	2	2	2
CO2	2	2	1	3	2	2
CO3	3	3	1	3	2	2
CO4	3	3	1	3	2	2
CO5	2	2	1	2	1	2

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGM2401MO PARTIAL DIFFERENTIAL EQUATIONS

(THEORY)

Class: M.Sc. Mathematics	**Semester**: II	**Hours per week:** 5 hrs./wk.

Cos	**COURSE OUTCOMES**	**COGNITIVE LEVEL**
On successful completion of the course, the student will be able to		
CO1	solve the first order linear and non-linear partial differential equations	K2 Understand
CO2	discuss different methods of solving Partial Differential Equation	K3 Apply
CO3	classify second order partial differential equation, solve problems of one-dimensional wave equations and vibrations of strings	K4 Analyse
CO4	evaluate problems on strings	K5 Evaluate
CO5	explain heat equation and wave equation	K6 Create

COURSE CONTENT:

UNIT I : PARTIAL DIFFERENTIAL EQUATION OF THE FIRST ORDER 15 hrs.

Origin of first order partial differential equations – Cauchy's problem – linear equations – integral surfaces passing through a given curve – surfaces orthogonal to a given system of surfaces – non- linear partial differential equations

UNIT II : PARTIAL DIFFERENTIAL EQUATION OF FIRST ORDER CONTINUED 15 hrs.

Cauchy's method of characteristics – compatible systems of first order equations – Charpit's method – special types of first order equations – solutions satisfying given conditions – Jacobi's method.

UNIT III : PARTIAL DIFFERENTIAL EQUATION OF SECOND ORDER 15 hrs.

Genesis of second order partial differential equation – classification of second order partial differential equation – one dimensional Wave Equation: vibrations of an infinite string – vibration ofa semi-infinite string – vibration of a string of finite length (method of separation of variables).

UNIT IV : PARTIAL DIFFERENTIAL EQUATION OF SECOND ORDER CONTINUED 15 hrs.

Riemann's Method – vibrations of a string of finite length – Laplace's equation – boundary value problems – maximum and minimum principles – Cauchy Problems.

UNIT V : HEAT CONDUCTION PROBLEM AND DUHAMEL'S PRINCIPLE 15 hrs.

Heat conduction problem – heat conduction infinite rod case – heat conduction finite rod case – Duhamel's principle: wave equation – heat conduction equation.

TEXTBOOK(S):

Amaranath T., (2017). *An Elementary Course in Partial Differential Equations*, (2nd ed.), New Delhi: Narosa Publishing House. Print. (Chapter 2(2.1 – 2.3, 2.4(2.4.1 – 2.4.3), 2.5,2.6))

Sneddon Ian., (1988). *Elements of Partial Differential Equations*, (International students edition),Singapore: McGraw Hill Book & Co. Print. (Chapter 2(2. 1 – 2.13)).

REFERENCE BOOK(S):

Deo S.C. and Raghavendra V. (2002), *Ordinary differential equations and stability theory***,** New Delhi; Tata McGraw Hill Publishing Company Limited. Print.

Dutta B.K, (1993). *An introduction to partial differential equations,* Calcutta: New Central BookAgency (P) Ltd. Print.

Garrett Birkoff and Gian – Carlo Rota., (1978). *Ordinary differential equations,* (3rd ed.), New York: John Wiley and sons. Print.

Sankara Rao K., *(2004). Introduction to partial differential equations,* New Delhi: Prentice hall of India Private Limited. Print.

MAPPING: COs consistency with PSOs

PGM2401MO PARTIAL DIFFERENTIAL EQUATIONS						
CO/PSO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	3	2	2	2	3
CO2	3	3	3	3	2	3
CO3	3	3	2	3	3	3
CO4	3	2	2	3	3	2
CO5	2	2	3	3	3	2

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1), No correlation (0)

PGM2402MO NUMERICAL ANALYSIS

(THEORY)

Class: M.Sc. Mathematics	**Semester**: II	**Hours per week:** 5 hrs./wk.
Cos	**COURSE OUTCOMES**	**COGNITIVE LEVEL**
On successful completion of the course, the student will be able to		
CO1	find the numerical solution of simultaneous equations by appropriate methods	K1 Remember
CO2	find the eigen values and eigen vectors of matrices using different methods	K1 Remember
CO3	Calculate the approximate value of the derivatives of a given function	K3 Apply
CO4	apply different methods to find approximate solution of integral equations	K3 Apply

CO5	solve first order ordinary differential equations numerically	K6 Create

COURSE CONTENT:

UNIT I : SOLUTION OF SIMULTANEOUS LINEAR ALGEBRAIC EQUATION: 15 hrs.

Gauss elimination method – Gauss-Jordan elimination method – method of triangular decomposition – Iteration methods of solving simultaneous equations – Jacobi iteration method – Gauss-Seideliteration method.

UNIT II : EIGEN VALUES 15 hrs.

Eigen values and eigen vectors – Jacobi method for symmetric matrices – Givens method –Householder's method.

UNIT III : NUMERICAL DIFFERENTIATION 15 hrs.

Numerical differentiation – extrapolation methods – partial differentiation.

UNIT IV : NUMERICAL INTEGRATION 15 hrs.

Methods based on undetermined coefficients – Gauss Quadrature methods – Gauss-Legendreintegration methods – Gauss-Chebyshev integration methods.

UNIT V : ORDINARY DIFFERENTIAL EQUATIONS 15 hrs.

Singlestep methods – Taylor series method – Runge-Kutta methods: Explicit Runge-Kutta methods (second and fourth order methods only) (without truncation error)

TEXTBOOK(S):

Jain M.K., Iyengar S.R.K. & Jain R.K.., (2003). *Numerical Methods for Scientific and EngineeringComputation* (4th ed.), New Delhi: New Age International (P) limited Publishers. Print. (Chapter 3:.2,3.4(pages 115 - 140,153-158), 3.5,3.7-3.9(pages 176 - 180,186-199), 5:5.2,5.4,5.5(pages 328 - 343,347-353), 5.8(pages 365 – 378), 6 (6.4) (pages 445 - 458)).

REFERENCE BOOK(S):

Jain., (2014). *Numerical solution of differential equations* (2nd ed)., New Delhi: New Age International (P) limited Publishers. Print.

Samuel D. Conte, Carl De Boor., (2005). *Elementary Numerical Analysis*, New York: McGraw- Hill International Edition. Print.

Curtis F. Gerald & Patrick O. Wheatley., (2003). *Applies Numerical Analysis,* New Delhi: Addison- Wesley Publishing Company Pearson Education. Print.

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PGM2402MO NUMERICAL ANALYSIS	
Class: I M.Sc. Mathematics	**Semester: II**
Cognitive Level	K-1 Remember
	K-3 Apply
	K- 5 Evaluate
	K-6 Create

MAPPING: COs consistency with PSOs

PGM2402MO NUMERICAL ANALYSIS						
	PSO					
CO/PSO	1	2	3	4	5	6
CO1	3	2	3	2	2	2
CO2	3	2	3	2	2	2
CO3	3	2	3	2	2	2
CO4	3	2	3	2	2	2
CO5	3	2	3	2	2	2

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1), No correlation (0)

PGM2403MO CLASSICAL MECHANICS

(THEORY)

Class: M.Sc. Mathematics	**Semester**: II	**Hours per week:** 5 hrs./wk.

Cos	**COURSE OUTCOMES**	**COGNITIVE LEVEL**
On successful completion of the course, the student will be able to		
CO1	explain the D'Alembert's principle, Newton's law for a system of particles and the concept of dissipation function	K2 Understand
CO2	find the equation of motion of a mechanical system using Lagrangian and Hamiltonian formulations	K1 Remember
CO3	classify the orbits of motion and reduce two body problem to an equivalent one body problem and prove related results	K2 Understand
CO4	identify the central forces in closed orbits and prove related results	K3 Apply
CO5	change the basis from one set of co-ordinates to another using the Legendre transformation	K6 Create

COURSE CONTENT:

UNIT I : ELEMENTARY PRINCIPLES **15 hrs.**

Mechanics of a particle – Mechanics of a system of particles – constraints – D'Alembert's principleand Lagrange's equations – velocity–dependent potentials and dissipation function.

UNIT II : VARIATIONAL PRINCIPLES AND LAGRANGE'S EQUATIONS **15 hrs.**

Hamilton's principle – some techniques of the calculus of variations – derivation of Lagrange'sequations from Hamilton's principle – extension of Hamilton's principle to nonholonomic systems.

UNIT III : ONE-BODY PROBLEM AND CLASSIFICATION OF ORBITS **15 hrs.**

Reduction to the equivalent one – body problem – equations of motion and first integrals – equivalent one-dimensional problem and classification of orbits – virial theorem.

UNIT IV : THE TWO–BODY CENTRAL FORCE PROBLEM **15 hrs.**

The differential equation for the orbit and integrable power–law potentials – conditions for closed orbits (Bertrand's theorem) – Kepler problem: Inverse square law of force.

UNIT V : THE HAMILTON EQUATIONS OF MOTION **15 hrs.**

Legendre transformations and the Hamilton equations of motion – Cyclic coordinates andconservartion theorems.

TEXTBOOK(S):

Herbert Goldstein, (2018). *Classical Mechanics,* (2nd ed.), New Delhi: Narosa Publishing House,Print. (Chapters: 1(1.1 – 1.5), 2(2.1 – 2.4), 3(3.1–3.7), 8(8.1,8.2))

REFERENCE BOOK(S):

Donald T. Greenwood, (2016). *Classical Dynamics,* New York: Dover Publications Inc. Print. Gupta S.L., Kumar V. and Sharma H.V., (2017). *Classical Mechanics,* Meerut: Pragati Prakashan. Print.

John L. Synge and Byron A. Griffith, (1970). *Principles of Mechanics,* (3rd ed.), *New* Delhi: *Tata* Mc.Graw Hill Book Company Inc. Print.

MAPPING: COs Consistency with PSOs

PGM2403MO CLASSICAL MECHANICS						
CO/PSO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	2	2	3	3	2
CO2	2	2	2	2	3	2
CO3	2	2	2	2	2	2
CO4	2	2	2	2	2	2
CO5	2	2	2	2	2	2

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1), No correlation (0)

PGM2301CT RESEARCH METHODOLOGY

(LAB CUM THEORY)

Class: M.Sc. Mathematics	**Semester**: II	**Hours per week:** 4 hrs./wk.

Cos	**COURSE OUTCOMES**	**COGNITIVE LEVEL**
On successful completion of the course, the student will be able to		
CO1	explain the meaning and significance of research	K2 Understand
CO2	interpret the research problem	K3 Apply
CO3	omit plagiarism while writing a report	K1 Remember
CO4	make use of LaTeX code to prepare a project report	K3 Apply
CO5	create a presentation using Beamer	K6 Analyze

COURSE CONTENT:

UNIT I : MEANING OF RESEARCH AND RESEARCH DESIGN **10T hrs.**

Research methodology: Introduction – meaning of research – objectives of research – motivation in research – types of research – research approaches – significance of research –defining the research problem– selecting the problem – necessity of defining the problem – technique involvedin defining a problem – research design – meaning of research design – need for research design – features of a good design.

UNIT II : INTERPRETATION **10T hrs.**

Interpretation and report writing – meaning of interpretation – significance of interpretation – technique of interpretation – precaution in interpretation.

UNIT III : REPORT WRITING ANDPLAGIARISM **10T hrs.**

Significance of report writing – different steps in writing report – layout of the research report – types of reports – oral presentation – Plagiarism–meaning of plagiarism – typesof plagiarism – glossary – Preventing plagiarism when writing

UNIT IV : INTRODUCTION TO LATEX **15L hrs.**

Latex documentation preparing an input file – paragraphs – special symbols –mathematical formulae **– defining commands and environments – type style.**

UNIT V : PRESENTATION USING LATEX **15L hrs.**

Cross reference – bibliography – preparing one's own document – errors – bibliography database – preparing slides using Beamer.

TEXTBOOK(S):

Kothari C.R., (2012). *Research Methodology (Methods and Techniques),* 2nd ed., New Delhi: NewAge International Publishers. (UNITS I, II). Print.

Leslie Lamport, (2003). *A Document Preparation System LaTeX User's Guide and ReferenceManual, New* Delhi: Pearson Education. (UNIT IV, V). Print.

WEBSITE(S):

http://www.plagiarism.org/plagiarism-101/what-is-plagiarism/(UNIT III)

REFERENCE BOOK(S):

Nambudiripad K. B. M., (2014). *LaTeX for beginners*, New Delhi: Narosa Publishing House Pvt Ltd.Print.

Ranjit Kumar, (2011). Research Methodology, *A step-by step guide for beginners* (3rd ed.), London: Sage Publications, Print.

Santosh Gupta, (2005). *Research Methodology and Statistical Techniques***,** New Delhi: Deep & Deep Publications, Print.

PGM2301CT RESEARCH METHODOLOGY	
Class: I M. Sc. Mathematics	**Semester: II**
Cognitive Level	K-1 Remember
	K-2 Understand
	K-3 Apply
	K-6 Create

MAPPING: COs consistency with PSOs

PGM2301CT RESEARCH METHODOLOGY						
CO/PSO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1	1	3	1	1	2
CO2	1	1	3	1	1	2
CO3	1	1	1	3	3	1
CO4	1	1	2	3	3	1
CO5	1	1	2	3	3	1

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1), No correlation (0)

PGM2201EI ANALYTICAL SKILLS FOR COMPETITIVE EXAMINATIONS (THEORY)

Class: M.Sc. Mathematics	**Semester**: II	**Hours per week:** 4 hrs./wk.
Cos	**COURSE OUTCOMES**	**COGNITIVE LEVEL**
On successful completion of the course, the student will be able to		

CO1	apply short-cut techniques to solve arithmetical problems	K3 Apply
CO2	find the simple interest, compound interest, dividend, profit and loss	K1 Remember
CO3	solve problems in mensuration with speed and accuracy	K3 Apply
CO4	interpret data represented graphically to solve problems	K3 Apply
CO5	analyse critically and find the solution of mathematical puzzle	K4 Analyze

COURSE CONTENT:

UNIT I : ARITHMETICAL ABILITY **12 hrs.**

Averages – percentages – ratio and proportions – time and work – time and distance.

UNIT II : BUSINESS MATHEMATICS **12 hrs.**

Simple interest – compound interest – stocks and shares – profit and loss.

UNIT III : MENSURATION **12 hrs.**

Area – volume and surface areas.

UNIT IV : DATA INTERPRETATION **12 hrs.**

Bar graphs – pie charts – line graphs.

UNIT V : VERBAL AND NON-VERBAL REASONING **12 hrs.**

Logical reasoning – Mathematical puzzles.

TEXTBOOK(S):

Aggarwal R.S. (2015), *Quantitative Aptitude,* New Delhi :S. Chand& Company Pvt. Ltd. Print.(Chapter 6, 10,11,12,15,17,21,22,24,25,29,37,38,39).

Aggarwal R.S., (2015). *Modern approach to verbal and nonverbal reasoning*, New Delhi: S. Chand &company Pvt. Ltd. Print. (Part I – Section I: 5, 6, 8, Part II – 1, 5, 6)

REFERENCE BOOK(S):

Alok Kumar, (2008). *CSIR/UGCNET/JRF/SET Mathematics Sciences*, New Delhi: UpkarPrakashan.Print.

Edgar Thrope, (1989). *A course in mental ability and quantitative aptitude for competitiveexaminations,* New Delhi: Tata McGraw Hill Publishing Company Limited. Print.

PGM2202EI DISCRETE MATHEMATICS

(THEORY)

Class: M.Sc/M.A	**Semester**: II	**Hours per week:** 4 hrs./wk.

Cos	**COURSE OUTCOMES**	**COGNITIVE LEVEL**
On successful completion of the course, the student will be able to		
CO1	construct truth tables for compound statements and derive different formulae	K3 Apply
CO2	modify a logical formula into different normal forms	K4 Analyse
CO3	solve problems in propositional calculus	K3 Apply
CO4	find the adjacency matrix and prove related	K1 Remember
CO5	list the properties of a tree structure and solve problems	K6 Create

COURSE CONTENT:

UNIT I : MATHEMATICAL LOGIC **12 hrs.**

Statements and notations – connectives – well-formed formulas – tautologies – equivalence offormulas – duality law – tautological implications – other connectives.

UNIT II : NORMAL FORMS **12 hrs.**

Disjunctive normal forms – conjunctive normal forms – principal disjunctive normal forms – principal conjunctive normal forms.

UNIT III : THEORY OF INFERENCE FOR THE STATEMENT CALCULUS **12 hrs.**

Validity using truth tables – rules of inference – consistency of premises and indirect method of proof.

UNIT IV : INTRODUCTION TO GRAPHS **12 hrs.**

Basic concepts – isomorphism and subgraphs.

UNIT V : TREES **12 hrs.**

Definition – properties of trees.

TEXTBOOK(S):

Mott J.L., Kandel A., Baker. T.P., (2009). *Discrete maths for computer scientists & mathematicians,* (2^{nd}ed.) New Delhi: Prentice Hall of India Pvt. Limited. Print. (Chapter 5 : 5.1 to 5.3).

Tremblay J.P. and Manohar R., (2005). *Discrete mathematical structures with applications to computer science,* (2^{nd} ed.) New Delhi: Tata McGraw Hill publishing company limited. Print. (Chapter 1:1.1,1.2(1.2.1 to 1.2.4 ,1.2.6 -1.2.11,1.2.14),1.3(1.3.1 to 1.3.4),1.4(1.4.1to1.4.3)).

REFERENCE BOOK(S):

Arumugam.S and Ramachandran S., (2010). *Invitation to graph theory,* Chennai: Scitech publications private Limited. Print.

Chowdhary K.R., (2012). *Fundamentals of discrete mathematical structures,* (2^{nd} ed.),New Delhi:PHI Learning Private Limited. Print.

Seymour Lipschutz and Mark Lipson., (2010). *Discrete mathematics*, *(*3^{rd} ed.), New Delhi: TataMcGraw Hill publishing Co. Ltd. Print.

Venkataraman M.K., Sridharan N. and Chandrasekaran N., (2001). *Discrete mathematics,* Chennai:The National publishing company. Print.

From 2021 batch onwards

Profile of semesters III and IV

Sem.	Course Code	Course Title	Course Type	Hrs./Wk.		Credits	Passed in Academic Council	Offered to	Offered by
				TH	LA				
III	PGM3405CM	MEASURE AND INTEGRATION	TH	5		4	BB2019	APMAT	MAT
	PGM3406CM	TOPOLOGY	TH	5		4	BB2019	APMAT	MAT
	PGM3403CM	GRAPH THEORY	TH	5		4	BA2018	APMAT	MAT
	PGM3407CM	CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS	TH	5		4	BE2020	APMAT	MAT
	PGM3401MO / PGM3402MO	FLUID DYNAMICS/ OPERATIONS RESEARCH	TH	5		4	BA2018	APMAT	MAT

	PGM3201EI	**ANALYTICAL SKILLS FOR COMPETITIVE EXAMINATIONS**	**TH**	**4**		**2**	**BE 2019**	**APMAT**	**MAT**
	PGM3202EI	**FUZZY SETS AND ITS APPLICATIONS**							
	PGV3001PV	BASIC TENETS OF MAJOR RELIGIONS							
	PGV3002PV	CULTURAL HERITAGE AND VALUES IN INDIA		1		-		ALLM	**Centre for VE**
	PGV3003PV	PROFESSIONAL ETHICS							
	PIV3001PI	BIBLICAL ETHICS							
	TOTAL			**30**		**22**			
IV	PGM4502CM	MODULE THEORY	TH	6		5		APMAT	APMAT
	PGM4503CM	FUNCTIONAL ANALYSIS	TH	6		5		APMAT	APMAT
	PGM4501CM	STOCHASTIC PROCESSES	TH	6		5		APMAT	APMAT
	PGM4504CM	NUMBER THEORY	TH	5		5		APMAT	APMAT
	PGM 0401PR	PROJECT		5		4		APMAT	APMAT
	PGV4001PV	UNIVERSAL VALUES							
	PGV4002PV	PEACE STUDIES AND PEACE MAKERS							
	PGV4003PV	IN TUNE WITH NATURE	**TH**	**2**		**-**	BE2020		
	PIV4001PI	BIBLICAL PERSPECTIVES ON GENDER							
	TOTAL			**30**		**24**			

PGM3405CM MEASURE AND INTEGRATION

(THEORY)

COURSE OUTCOMES: **5 hrs./wk.**

On successful completion of the course, the student will be able to

CO1: discuss the Lebesgue measurability of a given set

CO2: explain the concepts of measurable functions

CO3: interpret the properties of Lebesgue integrals of bounded, non-negative and measurable functions via theorems

CO4: examine the types of measures and their properties

CO5: develop the concept of outer measure to general measure

COURSE CONTENT:

UNITI: LEBESGUE MEASURE **18 hrs**.

Lebesgue outer measure – σ-algebra of Lebesgue measurable sets – outer and inner approximation of Lebesgue measurable sets – countable additivity– continuity– Borel-Cantelli lemma – non-measurable sets –Cantor set and the Cantor - Lebesgue function.

UNIT II: LEBESGUE MEASURABLE FUNCTIONS **15 hrs.**

Sums, products and compositions – sequential pointwise limits and simple approximation – Littlewood's three Principles – Egoroff's theorem – Lusin's theorem.

UNIT III: LEBESGUE INTEGRATION **18 hrs.**

The Riemann integral – Lebesgue integral of a bounded measurable function over a set of finite measure – Lebesgue integral of a measurable nonnegative function –general Lebesgue integral – countable additivity and continuity of integration.

UNIT IV: **GENERAL MEASURE SPACES** **12 hrs.**

Measures and measurable sets – signed measures: Hahn and Jordan Decompositions – Caratheodory measure induced by an outer measure.

UNIT V: INTEGRATION OVER GENERAL MEASURE SPACES **12 hrs.**

Measurable functions – integration of nonnegative measurable functions – integration of general measurable functions.

TEXTBOOK(S):

Royden H.L., Fitzpatrick P.M., (2019). *Real Analysis,* (4th ed.), Delhi: PHI Learning Pvt. Ltd. Print. (Chapter 2,3,4(4.1 – 4.5),17(17.1-17.3),18(18.1-18.3(up to Lebesgue Dominated Convergence Theorem))

REFERENCE BOOK(S):

De Barra, (2006). *Measure Theory and Integration*, New Delhi: New Age International limited. Print.

Halmos, (2000). *Measure Theory,* New Delhi: Narosa Publishing House. Print.

WEBLINK(S):

Inder K Rana(Mar 5,2015).Lebesgue Integral and its properties [Video file]. Retrieved fromhttps://www.youtube.com/watch?v=rxQmgxg3o5Y. CC BY license.

Krishna Jagannathan.(Feb 19,2015).Mod 01 Lec-09 Borel sets and Lebesgue Measure -1 [Video file]. Retrieved fromhttps://www.youtube.com/watch?v=z7-OerO97Cs&t=211s. CC BY license.

Krishna Jagannathan.(Feb 19,2015).Mod 01 Lec-10 Borel sets and Lebesgue Measure -2[Video file]. Retrieved fromhttps://www.youtube.com/watch?v=XNPPLX75hss.CC BY license.

Krishna Jagannathan.(Feb 19,2015).Mod 01 Lec-31monotone Convergence theorem[Video file]. Retrieved fromhttps://www.youtube.com/watch?v=XNPPLX75hss.CC BY license.

Krishna Jagannathan.(Feb 19,2015).Mod 01 Lec-34 Fatour'sLemmat and dominated convergence theorem[Video file]. Retrieved fromhttps://www.youtube.com/watch?v=-lvBTjTXvb4.CC BY license.

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COs cognitive level and mapping with PSOs:

PGM3405CM MEASURE AND INTEGRATION							
Class: IIM.Sc Mathematics				**Semester: III**			
CO/PSO	**Cognitive Level**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	K2 - Understand	2	2	1	2	1	2
CO2	K2 - Understand	2	2	1	2	1	2
CO3	K3 - Apply	2	2	1	2	1	2
CO4	K4-Analyze	2	2	1	2	1	2
CO5	K6 - Create	2	2	1	2	1	2

Strongly Correlated (3), Moderately Correlated (2), Weakly Correlated (1)

PGM3406CM TOPOLOGY

(THEORY)

COURSE OUTCOMES: **5 hrs./wk.**

On successful completion of the course, the student will be able to

CO1:summarize the results on limit points, interior and closure of a set in different topologies

CO2:applythe concepts of continuous functions on product topology and metric topology

CO3:relate the connectedness and compactness of a topological space via different theorems

CO4:make use of the concept of normal spaces to prove related theorems

CO5:prove the Tychonoff theorem and results on Stone-Cech compactification

COURSE CONTENT:

UNIT I: TOPOLOGICAL SPACES **15 hrs.**

Topological spaces – basis for a topology–order topology –product topology on XxY–subspace topology – closed sets and limit points.

UNIT II: CONTINUOUS FUNCTIONS **15 hrs.**

Continuous functions –product topology –metric topology.

UNIT III: CONNECTEDNESS AND COMPACTNESS **15 hrs.**

Connected spaces – connected subspaces of the real line – compact spaces – compact subspaces of the real line – limit point compactness.

UNIT IV: COUNTABILITY AND SEPARATION AXIOMS **15 hrs.**

Countability axioms (definitions only) – separation axioms– normal spaces –Urysohn lemma –Urysohnmetrization theorem – Tietze extension theorem.

UNIT V: THE TYCHONOFF THEOREM **15 hrs.**

Tychonoff theorem – Stone-Cech compactification.

TEXTBOOK(S):

James R. Munkres, (2011). *Topology,* (2nd ed.), New Delhi: Prentice Hall of India Private Limited. Print. (Chapter 2(12–21), 3(23, 24, 26 - 28), 4(30(definitions only), 31(only theorems), 32(only theorems), 33 to 35), 5(37,38).

REFERENCE BOOK(S):

Gupta B.D., (2015). *Topology*, New Delhi: Kedar Nath Ramanath Publishers. Vimal offset Printers. Print.

James Dugundji, (1975). *Topology,* New Delhi: Prentice Hall of India Private Limited. Print.

COs cognitive level and mapping with PSOs:

PGM3406CM TOPOLOGY							
Class: IIM.Sc Mathematics				**Semester: III**			
CO/PSO	**Cognitive Level**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	K2 - Understand	2	0	2	2	2	2
CO2	K3 - Apply	2	0	2	2	2	2
CO3	K3 - Apply	2	0	2	2	2	2
CO4	K3 - Apply	2	0	2	2	2	2
CO5	K5- Evaluate	2	0	2	2	2	2

Strongly Correlated (3), Moderately Correlated (2), Weakly Correlated (1)

WEBLINK(S):

The Grade Academy.(2020,Jul 15).*Topological Space Definition | Topology Definition with Examples | MSc Mathematics Lectures* [Video file].Retrieved from https://youtu.be/JxTcbd7fO-M. CC BY license.

Nptelhrd.(2014,Oct 10).Continuity *and Related Concepts Chapter 1* [Video file]. Retrieved from https://youtu.be/AR6sPMz3GKYCC BY license.

Nptelhrd.(2016,Jan19).Mod-06 Lec-26 ConnectednessContinuity *and Related Concepts Chapter 1* [Video file]. Retrieved from https://youtu.be/RJBJIIQFihw.CC BY license.

PGM3403CM GRAPH THEORY

(THEORY)

COURSE OUTCOMES: **5 hrs./ wk.**

On successful completion of the course, the student will be able to

CO1: describe connectivity and traversability of a graph with necessary and sufficient conditions

CO2:identify the types of digraphs and prove the results on tournaments and decision-making problems

CO3: construct the matching, factorization and graceful labelings of graphs

CO4: examine planarity and coloring of a graph with related results on the same

CO5: develop the bounds for the domination number of a graph

COURSE CONTENT:

UNIT I: CONNECTIVITY AND TRAVERSABILITY **18 hrs.**

Cut vertices – blocks – connectivity – Menger's Theorem – Eulerian graphs – Hamiltonian graphs – Hamiltonian walks and numbers

UNIT II: DIGRAPHS **15 hrs.**

Strong digraphs – tournaments – decision making

UNIT III: MATCHINGS AND FACTORIZATION **15 hrs.**

Matchings – factorization – decompositions and graceful labelings – Petersen graph

UNIT IV: PLANARITY AND COLORING **15 hrs.**

Planar graphs – embedding graphs on surfaces – graph minors – Four color problem – vertex coloring – edge coloring – Heawood map coloring theorem

UNIT V: DOMINATION **12 hrs**.

The domination number of a graph – bounds – open domination number and its bounds

TEXTBOOK(S):

Gary Chartrand & Ping Zhang, (2006). *Introduction to Graph Theory*, New Delhi: Tata McGraw – Hill Publishing Company Ltd. Print. (Chapter 5(5.1-5.4),6(6.1-6.3),7(7.1-7.3),8 (8.1-8.3, 8.5), 9(9.1-9.3),10(10.1-10.4),13(13.1)

REFERENCE BOOK(S):

Kumaravelu S. & SusheelaKumaravelu, (1999). *Graph Theory*, Sivakasi: Janaki Calendar corporation. Print.

Harary, (2001). *Graph theory,*NewDelhi: Narosa Publishing House Pvt Ltd. Print.

WEBLINK(S):

Lioyd B. (2016, November 6). *Directed Graphs*. [Video file]. Retrieved from https://youtu.be/by1zmpTxXIk. CC BY license.

Center of Math. (2019, March 5). *Graph Theory: Tournaments*. [Video file]. Retrieved from https://youtu.be/p5iKImnYbAo. CC BY license

Graph theory for educators. (2016, February 16). *Menger's Theorem - 13.* [Video file]. Retrieved from https://youtu.be/dUAeleBMRCQ. CC BY license.

Itechnica.(2018, July 24). *Connectivity-Vertex & Edge Connectivity*. [Video file].Retrieved from https://youtu.be/R9R9hhue614. CC BY license.

Itechnica. (2019, June 6). *Matching / Independent Edge Set*.[Video file].Retrieved from https://youtu.be/_JXUnhNhNYc .CC BY license.

Math at Andrews. (2020, March 22). *Graph Theory 4: Non-Planar Graphs &Kuratowski'sTheorem*.[Video file].Retrieved from https://youtu.be/3HyVIKBzZ3g. CC BY license.

Patrick JMT. (2010, November 17). *Euler Circuits and Euler Paths*.[Video file].Retrieved from https://youtu.be/REfC1-igKHQ. CC BY license.

Udacity.(2016, June 6).*Maximal and maximum matching*.[Video file].Retrieved from https://youtu.be/bOJC93XxoFc.. CC BY license.

Video Empress. (2016, May 9). *Graceful labelling*. [Video file].Retrieved from https://youtu.be/QNqdIRQuEH0. CC BY license.

Sarada Herke. (2015, May 29). *Planar Graphs*.[Video file].Retrieved from https://youtu.be/wnYtITkWAYA. CC BY license.

Sarada Herke. (2015, August 1*). Colorability – vertex coloring* .[Video file].Retrieved from - https://youtu.be/4FE79y_JkCE. CC BY license.

SunilkumarHosamani. (2020, April 23). *Examples for Domination number*.[Video file].Retrieved from - https://youtu.be/7NuM5unQYt4. CC BY license.

Up and Atom. (2018, August 20). *The Four Color Theorem | Coloring a Planar Graph* .[Video file].Retrieved from - https://youtu.be/42-ws3bkrKM. CC BY license.

Wrath of Math. (2019, August 18). *What are Graph Decompositions? | Graph Decomposition, Graph Theory*.[Video file].Retrieved from https://youtu.be/BiLjdZYj_RI. CC BY license.

COs cognitive level and mapping with PSOs:

PGM3403CM GRAPH THEORY							
Class: IIM.Sc Mathematics				Semester: III			
CO/PSO	**Cognitive Level**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	K2 - Understand	1	2	3	4	5	3
CO2	K2 - Understand	3	2	4	3	4	3
CO3	K3 - Apply	3	3	3	3	4	3
CO4	K4 -Analyze	3	3	2	3	4	3
CO5	K6- Create	3	3	2	3	4	3

Strongly Correlated (3), Moderately Correlated (2), Weakly Correlated (1)

PGM3407CM CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS

(THEORY)

COURSE OUTCOMES: **5 hrs. /wk.**

On successful completion of the course, the student will be able to

CO1: construct and solve the Euler's equations relevant to a large class of problems in calculus of variations.

CO2:apply Hamilton's principle and determine Lagrange's equations

CO3: employGreen's function to express differential equations

CO4: identify and solve Fredholm and Volterra equations

CO5: solve integral equations using iterative method

COURSE CONTENT:

UNIT I: MAXIMA AND MINIMA **12 hrs.**

Calculus of variations and applications: Maxima and minima – simplest case – illustrative examples – natural boundary conditions and transition conditions – variational notation – more general case.

UNIT II: LAGRANGE MULTIPLIERS AND LIOUVILLE PROBLEM **12 hrs.**

Constraints and Lagrange multipliers – variable end points – Sturm-Liouville problems – Hamilton's principle – Lagrange's equations

UNIT III: GREEN'S FUNCTION **12 hrs.**

Integral equations: Introduction – relations between differential and integral equations – Green's

function – alternative definition of Green's function.

UNIT IV: FREDHOLM EQUATIONS **12 hrs.**

Linear equation in cause and effect: Influence function – Fredholm equations ith separable kernels –illustrative example.

UNIT V: HILBERT SCHMIDT THEORY **12 hrs.**

Hilbert- Schmidt theory – iterative methods for solving equations of the second kind – Fredholm theory.

TEXTBOOK(S):

Francis B. Hildebrand, (2017). Methods of Applied Mathematics (2nd ed.), New York: DoverPublications. Print. (Chapter: 2.1 to 2.11, 3.1 to 3.9 and 3.11).

REFERENCE BOOK:

Gupta A.S., (1997). Calculus of Variations, India: PHI Learning Private limited. Print.

WEBLINK(S):

Dr.TreforBazett (2019, Feb 7) *Arclength Formula Derivation & Ex: Circumference of a Circle*. Video file. Retrieved from https://youtu.be/pH-Omj-cMok. CC by license.

Dr.TreforBazett (2019, Feb 9) *Areas of surfaces of revolution- Derivation and example*. Video file. Retrieved from https://youtu.be/zUzan1Ma9nE. CC by license.

Dr.TreforBazett (2019, Feb 9) *Lagrange Multipliers- Geometric meaning and full example*. Video file. Retrieved from https://youtu.be/8mjcnxGMwFo. CC by license.

MAL 644 Integral Equation, Directorate of Distance Education, Guru Jambeshwar University of Science and Technology, Hisar.

COs cognitive level and mapping with PSOs:

PGM3407CM CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS							
Class: IIM.Sc Mathematics				**Semester: III**			
CO/PSO	**Cognitive Level**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	K3-Apply	2	2	1	2	2	1
CO2	K3- Apply	2	2	1	2	1	1
CO3	K3- Apply	1	2	1	2	1	1
CO4	K3- Apply	2	1	1	2	1	1
CO5	K6- Create	2	2	1	2	2	1

Strongly Correlated (3), Moderately Correlated (2), Weakly Correlated (1)

PGM3401MO FLUID DYNAMICS

(THEORY)

COURSE OUTCOMES: **5 hrs./wk.**

On successful completion of the course, the student will be able to

CO 1: summarise results on the velocity and acceleration of a fluid at a point

CO 2: make use of Euler's equation and Bernoulli's equation in solving problems of practical importance

CO 3: solve problems on sources, sinks, doublets and stream function

CO 4: prove results involving two–dimensional flow of inviscid incompressible fluids

CO 5: prove results on stress components in a real fluid

COURSE CONTENT:

UNIT I: KINEMATICS OF FLUIDS IN MOTION **15 hrs.**

Real fluids and ideal fluids – velocity of a fluid at a point – streamlines and path lines – steady and unsteady flows – velocity potential –vorticity vector – local and particle rates of change – equation of continuity – worked examples – acceleration of a fluid – conditions at a rigid boundary – general analysis of fluid motion.

UNIT II: **EQUATIONS OF MOTION OF A FLUID** **15 hrs.**

Pressure at a point in a fluid at rest – pressure at a point in a moving fluid – conditions at a boundary of two inviscid immiscible fluids – Euler's equations of motion – Bernoulli's equation – worked examples – discussion of the case of steady motion under conservative body forces – some flows involving axial symmetry – some special two–dimensional flows – some further aspects of vortex motion.

UNIT III: **SOME THREE–DIMENSIONAL FLOWS** **15 hrs.**

Introduction – sources – sinks and doublets – axis symmetric flows – Stoke's stream function – some special forms of the stream function for axis – symmetric irrotational motions.

UNIT IV: **SOME TWO–DIMENSIONAL FLOWS** **15 hrs.**

Meaning of two–dimensional flow – use of cylindrical polar co–ordinates – stream function – complex potential for two-dimensional – irrotational – incompressible flow – complex velocity potential for standard two–dimensional flow: uniform stream – line sources and line sinks – line doublets – line vortices – some worked examples – Milne-Thomsom circle theorem – some applications of the circle theorem – extension of the circle theorem – theorem of Blasius.

UNIT V: **VISCOUS FLOW** **15 hrs.**

Stress components in a real fluid – relations between Cartesian components of stress – translational motion of fluid element – rate of strain quadric and principal stress – some further properties of the rate of strain quadric – stress analysis in fluid motion – relations between stress and rate of strain – coefficient of viscosity and laminar flow – the Navier-Stokes equations of motion of a viscous fluid – some solvable problems in viscous flow: steady motion between parallel planes – steady flow through tube of uniform circular cross section – steady flow between concentric rotating cylinders – steady viscous flow in tubes of uniform cross section: a uniqueness theorem – tube having uniform elliptic cross-section – tube having equilateral triangular cross-section – diffusion of vorticity – energy dissipation due to viscosity.

TEXT BOOK(S):

Chorlton F.,(2004). *Text book of fluid dynamics*, Delhi: CBS Publishers and Distributors. Print. (Chapters 2, 3.1 to 3.7, 3.9, 3.10, 3.12, 4.1, 4.2, 4.5, 5.1 to 5.6, 5.8, 5.9, 8.1 to 8.11(8.11.1–8.11.3), 8.12, 8.13).

REFERENCE BOOK(S):

Bansal J.L., (1986). *Viscous Fluid Dynamics*, Delhi: Oxford & IBH Publishers. Print.

Goyal and Gupta., (2016). Fluid Dynamics, Meerut: Pragati Prakashan educational publishers. Print.

Swarup S., (1984). *Fluid Dynamics*, Agra: Krishna prakashanMandhir Publishers. Print.

WEBLINK(S):

MECH 241. (2017, May3). *Fluid Mechanics I*[Video file].Retrieved from https://youtu.be/4qppw7dO7kM. CC BY license.

Nptelhrd.(2015,March 25).Dynamics of Viscous Flows:Navier Stokes Equation Video file].Retrieved from https://youtu.be/MSPTSseo-gs.CC BY license.

Nptelhrd. (2015, March 24). *Fluid Kinematics* [Video file]. Retrieved from https://youtu.be/whCu4Xl3m98. CC BY license.

COs cognitive level and mapping with PSOs:

PGM3401MO FLUID DYNAMICS							
Class: IIM.Sc Mathematics			**Semester: III**				
CO/PSO	**Cognitive Level**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**

CO1	K2 - Understand	1	2	3	4	5	3
CO2	K3 - Apply	3	2	4	3	4	3
CO3	K3 - Apply	3	3	3	3	4	3
CO4	K5- Evaluate	3	3	2	3	4	3
CO5	K5- Evaluate	3	3	2	3	4	3

Strongly Correlated (3), Moderately Correlated (2), Weakly Correlated (1)

PGM3402MO OPERATIONS RESEARCH

(THEORY)

COURSE OUTCOMES: **5 hrs./wk.**

On successful completion of the course, the student will be able to

CO 1 : construct network models and solve problems using algorithms

CO 2 : solve linear programming problems using appropriate method

CO 3 :make use of deterministic dynamic programming to solve problems

CO4 :decide on different alternatives on expected value criterion and make decision for relevant situations

CO 5 :adapt simulation techniques in Queuing systems and Inventory problems

COURSE CONTENT:

UNITI: NETWORK MODELS **15 hrs.**

Definition of network models – minimal spanning tree algorithm – maximal flow model: enumeration of cuts – maximal flow algorithm.

UNIT II: REVISED SIMPLEX METHOD AND INTEGER LINEAR PROGRAMMING **15 hrs.**

Standard forms for revised simplex method – computational procedure – comparison of simplex method and revised simplex method – branch and bound algorithm – cutting-plane algorithm.

UNIT III: DETERMINISTIC DYNAMIC PROGRAMMING **15 hrs.**

Recursive nature of computations in dynamic programming – forward and backward recursion – cargo loading model – work force size model.

UNIT IV: DECISION ANALYSIS **15hrs.**

Decision making under certainty – analytic hierarchy process – decision making under risk: decision tree based expected value criterion – variants of the expected value criterion – decision under uncertainty.

UNIT V: SIMULATION **15 hrs.**

Process of simulation – simulation models – event-type simulation – generation of random numbers – Monte-Carlo simulation – simulation of inventory problems – simulation of queuing system

TEXT BOOK(S):

Hamdy A. Taha, (2014). *Operations Research: An Introduction*, (9th Ed.), India: Pearson publication. Print. Chapters 6 (Sections: 1,2,4(4.1,4.2)), 8 (Section: 2),11 (Sections:1,2,3(3.1,3.2)), 13 (Sections:1,2,3).

Kanti Swarup, P.K. Gupta and Man Mohan, (2015). *Operations Research*, New Delhi: Sultan Chand and Sons. Print. Chapter 22(22.1–22.9)

Sharma J.K., (2009). *Operations Research Theory and Applications*, (3rd Ed.), Haryana: Macmillan India Ltd. Print. Chapter 26

REFERENCE BOOK(S):

Prem Kumar Gupta and Hira D.S., (2012). *Operations Research–An Introduction*, New Delhi: S. Chand and Co. Ltd. Print.

MichaeCarter,CamileC.Price,GhaithRabadi., (2018). *Operations Research a Practical Introduction*, United States: CRC Press, Print.

WEBLINK(S):

Arul Suju D. (2016, September 3). Dynamic Programming: Solving Linear Programming Problem using Dynamic Programming Approach [Video file]. Retrieved from https://youtu.be/6v6_2Lo3_J4.CC BY license.

Dbrownconsulting. (2018, May 20). How to Incorporate the Monte Carlo Simulation on your financial models [Video file]. Retrieved from https://youtu.be/bR3Rdif5mhY. CC BY license.

Mechpro classes. (2020, May 26). Maximal flow problem [Video file]. Retrieved from https://youtu.be/lqjfsYifLtM .CC BY license.

Mechpro classes. (2020, June 18). Branch and Bound Technique for Integer Programming [Video file]. Retrieved from https://youtu.be/GNENEr_HclU .CC BY license.

WIT Solapur – Professional Learning Community. (2019, January 24). Decision Making Under Certainty Solution by Assignment Method [Video file]. Retrieved from https://youtu.be/JufYC8AWf1Y. CC BY license.

COs cognitive level and mapping with PSOs:

PGM 3502MO OPERATIONS RESEARCH							
Class: IIM.Sc Mathematics				Semester: III			
CO/PSO	**Cognitive Level**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	K3 - Apply	3	2	2	2	2	2
CO2	K3 - Apply	3	3	1	3	3	2
CO3	K3 - Apply	3	3	1	3	3	2
CO4	K5 - Evaluate	3	3	2	3	3	2
CO5	K6 - Create	3	3	2	3	3	2

Strongly Correlated (3), Moderately Correlated (2), Weakly Correlated (1)

PGM3201EI ANALYTICAL SKILLS FOR COMPETITIVE EXAMINATIONS

(THEORY)

COURSE OUTCOMES: **4 hrs./wk.**

On successful completion of the course, the student will be able to

CO1: apply short-cut techniques to solve arithmetical problems

CO2: solve problems on simple interest, compound interest, dividend, profit and loss

CO3: make use of formulae to solve problems on mensuration with speed and accuracy

CO4: interpret data represented graphically

CO5: analyse critically to solve mathematical puzzles

COURSE CONTENT:

UNITI: ARITHMETICAL ABILITY **12 hrs.**

Averages–percentages–ratio and proportions–time and work – time and distance.

UNITII: BUSINESS MATHEMATICS **12 hrs.**

Simple interest–compound interest –stocks and shares –profit and loss.

UNITIII: MENSURATION **12 hrs.**

Area – volume and surface areas.

UNITIV: DATA INTERPRETATION **12 hrs.**

Bar graphs – pie charts – line graphs.

UNITV: VERBAL AND NON-VERBAL REASONING **12 hrs.**

Logical reasoning – Mathematical puzzles.

TEXTBOOK(S):

Aggarwal R.S. (2015), *Quantitative Aptitude,* New Delhi :S. Chand& Company Pvt. Ltd. Print. (Chapter 6, 10,11,12,15,17,21,22,24,25,29,37,38,39).

Aggarwal R.S., (2015). *Modern approach to verbal and nonverbal reasoning*, New Delhi: S. Chand &company Pvt.Ltd. Print. (Part I – Section I: 5, 6, 8, Part II – 1, 5, 6)

REFERENCE BOOK(S):

Alok Kumar, (2008). *CSIR/UGCNET/JRF/SET Mathematics Sciences*, New Delhi: UpkarPrakashan.Print. Edgar Thrope, (1989). *A course in mental ability and quantitative aptitude for competitive examinations,* New Delhi: Tata McGraw Hill Publishing Company Limited. Print.

WEBLINK(S):

Anuj Jindal.(2019,Oct 15).*Simplification | Quantitative Aptitude | RBI Phase 1.* [Video file]. Retrieved fromhttps://youtu.be/fAFlXhVK-IY. CC BY license.

Anuj Jindal.(2019,Oct 15).*Ratio and Proportion*[Video file]. Retrieved fromhttps://youtu.be/4OngdbGmC7w CC BY license.

Anuj Jindal.(2019,Oct 24).*Simple & Compound Interest*[Video file]. Retrieved fromhttps://youtu.be/LubavlpGgm. CC BY license.

Adda247. (2019, Feb 6). *SSC CGL | Mensuration Basics | Day 1* **.**[Video file]. Retrieved from https://youtu.be/CRDkH5vKtPM. CC BY license.

Best way to study. (2018, Jun 13). *Verbal And Non-Verbal Reasoning Part-2 (Crt) || Number Series Completion || Best Way To Study* **||.** [Video file]. Retrieved from https://youtu.be/xrvgdl4QdpI. CC BY license.

COs cognitive level and mapping with PSOs:

PGM3201EI ANALYTICAL SKILLS FOR COMPETITIVE EXAMINATIONS							
Class: IIM.Sc Mathematics				**Semester: III**			
CO/PSO	**Cognitive Level**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	K3 - Apply	3	2	2	2	2	2
CO2	K3 - Apply	3	3	1	3	3	2
CO3	K3 - Apply	3	3	1	3	3	2
CO4	K5 -Evaluate	3	3	2	3	3	2
CO5	K4 - Analyse	3	3	2	3	3	2

Strongly Correlated (3), Moderately Correlated (2), Weakly Correlated (1)

PGM3202EI FUZZY SETS AND ITS APPLICATIONS

(THEORY)

COURSE OUTCOMES: **4 hrs./wk.**

On successful completion of the course, the student will be able to

CO1: compare fuzzy sets and crisp sets and define fuzzy logic

CO2: find union, intersection and complement of fuzzy sets and prove the results on the same

CO3: discuss the properties of fuzzy relations and perform various compositions

CO4: construct fuzzy graphs and list the special fuzzy relations

CO5: apply fuzzy set theory in real life situations

COURSE CONTENT:

UNIT I: FUZZY SETS **12 hrs.**

Crisp sets and fuzzy sets – basic concept of fuzzy set – fuzzy logic.

UNIT II: FUZZY OPERATION **12 hrs.**

Fuzzy complement – fuzzy union – fuzzy intersection – combinations of operations.

UNIT III: FUZZY RELATION **12 hrs.**

Fuzzy relation on sets and fuzzy sets – composition of fuzzy relations – properties of the min-max composition.

UNIT IV: FUZZY GRAPHS **12 hrs.**

Fuzzy graphs – special fuzzy relations.

UNIT V: FUZZY APPLICATIONS **12 hrs.**

Fuzzy systems in medical field and genetic algorithm.

TEXTBOOK(S):

George J.K,& Bo Yuan, (1995).*Fuzzy sets and Fuzzy Logic Theory and Applications*, New Delhi: Prentice Hall of India Pvt. Ltd. Print. (Chapter:17(17.2,17.4))

George J. K ,& Tina A. Folger, (2008). *Fuzzy sets*, Uncertainty and Information, New Delhi: Prentice Hall of India Pvt. Ltd. Print. (Chapter: 1(1.1-1.4,1.6),2(2.1 -2.5))

Zimmermann H.J., (2006). *Fuzzy set Theory and its Applications*, (4th ed.), New Delhi: Springer Publication. Print. (Chapter: 6 (6.1-6.3)).

REFERENCE BOOK(S):

Meenakshi A. R., (2008). *Fuzzy Matrix Theory and Applications*, Chennai: MJP Publishers. Print.

WEBLINK(S):

Atta KodallaVantillu. (2019, April 1). *FL – Classical Relations – Operations and Properties* [Video file]. Retrieved from https://youtu.be/DzyCBHPTyIk. CC BY license.

Mohamed Salih Mukthar. (2020, May 6). *Fuzzy Sets – Basic concepts* [Video file]. Retrieved from https://youtu.be/RrseZK1obA CC BY license.

Muhammad Adam Fahmil 'Ilmi. (2018, March 11). *Fuzzy Logic Application in Real Life – Robotics*

[Video file]. Retrieved from https://youtu.be/DW1eegaH6Ys CC BY license.

Welcome Engineers. (2019, September 25). *Introduction to Graph in Tamil* [Video file]. Retrieved from https://youtu.be/iH5PYVhX-KsCC BY license.

Zax Ong. (2016, March 5). *Fuzzy Logic in Real Life concepts* [Video file] Retrieved fromhttps://youtu.be/v_laulkyBCQ .CC BY license.

COs cognitive level and mapping with PSOs:

PGM3202EI FUZZY SETS AND ITS APPLICATIONS							
Class: IIM.Sc Mathematics				**Semester: III**			
CO/PSO	**Cognitive Level**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	K2- Understand	3	2	2	2	2	2
CO2	K1 - Remember	3	3	1	3	3	2
CO3	K2 - Understand	3	3	1	3	3	2
CO4	K6 - Cretae	3	3	2	3	3	2
CO5	K3 - Apply	3	3	2	3	3	2

Strongly Correlated (3), Moderately Correlated (2), Weakly Correlated (1)

PGM4501CM STOCHASTIC PROCESSES

(THEORY)

COURSE OUTCOMES: **6 hrs. / wk.**

On successful completion of the course, the student will be able to

CO1: interpret the concept of Stochastic and Markov Processes, construct digraphs and form transition probability matrices

CO2: explain higher transition probabilities and prove theorems of Markov chains

CO3: demonstrate Poisson process and its applications

CO4: elaborate renewal process and explain properties of generating functions

CO5: discuss queuing systems and models

COURSE CONTENT:

UNIT I: INTRODUCTION, MARKOV CHAINS **15 hrs**.

Definition – examples and classification of stochastic processes – definition and examples of Markov Chains – transition matrix – Markov chain as graphs – classification of states and chains.

UNIT II: HIGHER TRANSITION PROBABILITIES **20 hrs.**

Theorems of Markov chains – determination of higher transition probabilities – stability of a Markov system – limiting behaviour – finite irreducible chains.

UNIT III: POISSON PROCESS AND ITS EXTENSIONS **20 hrs.**

Poisson process – postulates for Poisson process – derivation and properties of Poisson process – pure birth process: Yule-Furry process – birth immigration process – birth and death process.

UNIT IV: RENEWAL PROCESS **15 hrs.**

Renewal interval – renewal function and renewal density – renewal equation – renewal theorems – branching process – properties of generating functions – examples.

UNIT V: QUEUEING SYSTEMS AND MODELS **20 hrs.**

Queueing process – steady state distribution – Little's birth and death processes in queueing theory – the model M/M/S – Erlang loss model – Non-Markovian queueing models – queues with Poisson input – model M/G/1.

TEXTBOOK(S):

Medhi J., (2013). *Stochastic Processes,* (3rd ed.), New Delhi: New Age international publishers, Print. (Sections 1.5, 2.1 – 2.6, 3.1 – 3.2.1, 3.3.3 – 3.4.1, 6.1.1 – 6.5.1, 9.1 – 9.3.1, 10.1 – 10.3.1),

REFERENCE BOOK(S):

Karlin S & Taylor H.W. (2012). *A First Course in Stochastic Processes,* (2nd ed.), United Kingdom: Academic Press, Gulf Professional Publishing. Print.

Karlin S & Taylor H.W. (2012). *A Second Course in Stochastic Processes, (*2nd ed.) United Kingdom: Academic Press, Gulf Professional Publishing. Print.

Basu A.K., (2007). *Introduction to Stochastic Processes*, New Delhi: Narosa Publishing House. Print.

WEBLINK(S):

Nptelhrd. (2014, November 7). History and Prehistory: Probability Theory and applications [Video file]. Retrieved from https://youtu.be/l04F077ICkw. CC BY licence.

Nptelhrd. (2014, November 7). History and Prehistory: Probability Theory and applications [Video file]. Retrieved from https://youtu.be/c-hh-XaRKQ4. CC BY licence.

Nptelhrd. (2014, November 7). History and Prehistory: Probability Theory and applications [Video file]. Retrieved from https://youtu.be/vo2fX9thVQU. CC BY licence.

Nptelhrd. (2014, November 7). History and Prehistory: Probability Theory and applications [Video file]. Retrieved from https://youtu.be/IfwQ3wgwgU0. CC BY licence.

Nptelhrd. (2014, November 7). History and Prehistory: Probability Theory and applications [Video file]. Retrieved from https://youtu.be/cKZtw2h8xsE. CC BY licence.

COs cognitive level and mapping with PSOs:

PGM4501CM STOCHASTIC PROCESSES							
CO	**COGNITIVE LEVEL**	**PSO**					
		1	**2**	**3**	**4**	**5**	**6**
CO1	K-2 Understand	2	3	2	1	1	2
CO2	K-5 Evaluate	2	2	3	1	1	2
CO3	K-3 Apply	3	2	2	2	2	2
CO4	K-6 Create	2	3	2	2	2	2
CO5	K-6 Create	3	3	1	3	2	2

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGM4502CM MODULE THEORY

(THEORY)

COURSE OUTCOMES: **6 hrs./wk.**

On successful completion of the course, the student will be able to

CO1: define rings and ideals and prove related theorems

CO2: explain the concepts in modules and exact sequences

CO3: analyse the properties of rings and modules of fractions and develop extended and contracted ideals

CO4: discuss the concepts of Noetherian and Artinian A-modules and prove related theorems

CO5: prove the Hilbert Basis theorem and results on Noetherian and Artin rings

COURSE CONTENT:

UNIT I: **RINGS AND IDEALS** **18 hrs.**

Rings and ring homomorphisms – ideals – quotient rings – zero-divisors – nilpotent elements – units – prime ideals and maximal ideals – nilradical and Jacobson radical – operations on ideals – extension and contraction.

UNIT II: **MODULES** **18 hrs.**

Modules and module homomorphisms – submodules and quotient modules – operations on submodules – direct sum and product – finitely generated modules – exact sequences.

UNIT III: **RINGS AND MODULES OF FRACTIONS** **18 hrs.**

Rings and modules of fractions – local properties – extended and contracted ideals in rings of fractions**.**

UNIT IV: **CHAIN CONDITIONS** **18 hrs.**

Noetherian A-modules – Artinian A-modules – composition series.

UNIT V: **NOETHERIAN RINGS AND ARTIN RINGS** **18 hrs.**

Hilbert's Basis theorem – primary decomposition in Noetherian Rings– structure theorem for Artin rings.

TEXTBOOK(S):

Atiyah M F. & MacDonaldI G., (1994). *Introduction to Commutative Algebra*, London: Addison-Wesley Publishing Company, Print. (Chapters 1,2.1 to 2.9, 3(3.1-3.4, 3.8,3.9,3.11-3.16), 6,7 (7.1-7.6, 7.11 – 7-17) and 8.

REFERENCE BOOK(S):

Berrick A. J. & Keating M.E., (2000). *An introduction to rings and modules with K-theory in view,* NewYork: Cambridge University Press. Print.

Gopalakrishnan N S., (1988). *Commutative Algebra*, New Delhi: Oxonian Press Pvt. Ltd.. Print.

Musili C., (1999). *Introduction to Rings and Modules*, (2nd Revised ed.), New Delhi: Narosa Publishing House. Print.

WEBLINK(S):

Hanung Cho. (2019, May 13). *Definition of R-module* [Video file]. Retrieved from https://youtu.be/-bxCqbmgYzk. CC BY license.

Matthew Salomone. (2013, February 26). *Ideals* [Video file]. Retrieved from https://youtu.be/pTZrTN-jJ9M. CC BY license.

NPTEL. (2017, February 5). *Modules and Homomorphisms* [Video file]. Retrieved from https://youtu.be/wNDOTUWFR2M . CC BY license.

NPTEL, Prof. Krishna Hanumanthu (2019, Sep 13). *Noetherian rings* [Video file]. Retrieved from https://youtu.be/VOXP0KKG06Y . CC BY license.

NPTEL, Prof. A.V. Jayanthan(2017, May 25). *Hilbert Basis Theorem and Primary Decomposition* [Video file]. Retrieved from https://youtu.be/DcY8tdVQYtc. CC BY license.

NPTEL, Prof. Krishna Hanumanthu (2019, Sep 20). *Hilbert Basis Theorem* [Video file]. Retrieved from https://youtu.be/tr48tZE85_A. CC BY license.

NPTEL, Prof. Krishna Hanumanthu (2019, Sep 13). *Field of fractions, Noetherian rings* [Video file].

Retrieved from https://youtu.be/db2PaRNgBoA. CC BY license.

NPTEL, Dr. Dilip P. Patil. (2019, Dec 17). *Universal property of Modules of Fractions* [Video file].

Retrieved from https://youtu.be/Hn7JcCMewrc. CC BY license.

Richard E. Borcherds. (2020, August 3) *Commutative algebra -Rings, ideals, modules* [Video file]. Retrieved from https://youtu.be/TBtG2IldX4M. CC BY license.

Richard E. Borcherds. (2020, August 25). *Commutative algebra-Artinian rings* [Video file].

Retrieved from https://youtu.be/Pj4csWaCad8 . CC BY license.

COs cognitive level and mapping with PSOs:

Strongly

PGM4502CM MODULE THEORY							
CO	**COGNITIVE LEVEL**	**PSO**					
		1	**2**	**3**	**4**	**5**	**6**
CO1	K-1 Remember	3	1	2	3	2	3
CO2	K-2 Understand	3	1	2	3	2	2
CO3	K-4 Analyse	3	1	2	3	2	2
CO4	K-6 Create	3	1	2	3	2	3
CO5	K-5 Evaluate	3	1	2	3	2	3

correlated (3), Moderately correlated (2), Weakly correlated (1)

PGM4503CM FUNCTIONAL ANALYSIS

(THEORY)

COURSE OUTCOMES: **6 hrs./wk.**

On successful completion of the course the student will be able to

CO1: explain the fundamental properties of linear spaces and the transformations between them

CO5: prove the spectral theorem and results on spectrum of an operator

COURSE CONTENT:

UNIT I: ALGEBRAIC SYSTEMS **18 hrs.**

Linear spaces – dimension of a linear space – linear transformations – projections.

UNIT II: BANACH SPACES **18 hrs.**

Definition and some examples – continuous linear transformations – Hahn Banach theorem.

UNIT III: BANACH SPACES (continued) **18 hrs.**

The natural imbedding of N in N^{**} – open mapping theorem – closed graph theorem – conjugate of an operator.

UNIT IV: HILBERT SPACES **18 hrs.**

The definition and some simple properties – orthogonal complements – orthogonal sets – conjugate space H^*.

UNITV: FINITE DIMENSIONAL SPECTRAL THEORY **18 hrs.**

Matrices – determinants and the spectrum of an operator – spectral theorem.

TEXTBOOK(S):

Simmons G.F., (2010). *Introduction to Topology and Modern analysis*, Tokyo: McGraw Hill Kogakusha Ltd. Print. (Chapter: 8:42-44, 9: 46-51, 10: 52-55, 11: 60-62)

REFERENCE BOOK(S):

Sharma J N., Vasishtha A R., (2014). *Functional Analysis*, (35th ed.), Krishna Prakashan Media (P) Ltd. Print.

Chandrasekhara Rao K., (2002). *Functional Analysis*, New Delhi: Narosa Publishing House, Print.

Saran N , Shukla S L., (2001). *Functional Analysis*, Meerut: Pragati Prakashan. Print.

WEBLINK(S):

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COs cognitive level and mapping with PSOs:

PGM4503CM FUNCTIONAL ANALYSIS							
CO	**COGNITIVE LEVEL**	**PSO**					
		1	**2**	**3**	**4**	**5**	**6**
CO1	K-2 Understand	2	1	2	2	2	2
CO2	K-1 Remember	2	1	2	2	2	2
CO3	K-5 Evaluate	2	1	2	2	2	2
CO4	K-4 Analyse	2	1	2	2	2	2
CO5	K-5 Evaluate	2	2	2	2	2	2

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGM4504CM NUMBER THEORY AND CRYPTOGRAPHY

(THEORY)

COURSE OUTCOMES: **5 hrs. / wk.**

On successful completion of the course, the student will be able to

CO1: explain the concept of congruences and prove related results

CO2: discuss the properties of different arithmetical functions

CO3: derive Euler's summation formula and estimate the average order of different arithmetical functions

CO4: explain simple cryptosystems and encipher matrices

CO5: demonstrate public key cryptography

COURSE CONTENT:

UNIT I: DIVISIBILITY **15 hrs.**

Divisibility – greatest common divisor – fundamental theorem of arithmetic – Euclidean Algorithm – basic properties of congruences – residue classes and complete residue systems – linear congruences – polynomial congruences modulo p – Lagrange's theorem and its applications – chinese remainder Theorem.

UNIT II: ARITHMETICAL FUNCTIONS **15 hrs.**

Mobius function – Euler's Taution function – Dirichlet product of Arithmetical functions – Mangoldt functions – multiplicative functions – Liouville's function – Bell series of an arithmetical function – derivatives of arithmetical functions.

UNIT III: AVERAGE ORDER OF ARITHMETICAL FUNCTIONS **15 hrs.**

Euler's summation formula – Average order of d(n), $\Lambda(n), \sigma_\alpha(n), \mu(n), \phi(n)$ – partial sums of a Dirichlet product.

UNIT IV: CRYPTOGRAPHY **15 hrs.**

Cryptography – some simple cryptosystems – enciphering matrices.

UNIT V: PUBLIC KEY CRYPTOGRAPHY **15 hrs.**

Public key cryptography – idea of public key cryptography – RSA – discrete log –Knapsack cryptosystems.

TEXTBOOK(S):

Neal Koblitz., (1987). Graduate *Text in Mathematics A course in Number Theory and Cryptography,* New York: Springer – Verlag, Print. (Chapter 3, 4: 4.1 to 4.4).

Tom.M.Apostol., (1998**).** *Introduction to analytic Number theory***,** New Delhi: Narosa Publishing house, Eighth reprint. - Print. (Chapters 1 to 3,5: 5.1 to 5.7).

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David M Burton, (2007***).*** *Elementary Number Theory,* (6th ed.), New Delhi: Tata McGraw Hill Publishing House. Print.

Wade Trappe, Lawrence C Washington., (2007). *Introduction to Cryptography with coding theory*, (2nd ed.), New Delhi: Pearson Education. Print.

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For the Love of Math. (2020, May 21). *Encrypting and Decrypting Using Shift Cipher* [Video file]. Retrieved from https://youtu.be/eL9AmU5afR0. CC BY license.

MathPod. (2020, May 25). *Arithmetic Functions |Part-1| Sum and Divisor Function* [Video file]. Retrieved from https://youtu.be/5ltOfUUb-7U. CC BY license.

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Michael Penn. (2019, Sep 11). Number *Theory | When does a linear congruence have a solution??* [Video file]. Retrieved from https://youtu.be/ktJc8_3pKPw. CC BY license.

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SeeThruMaths. (2020, Jun 28). *Matrices in Cryptography* [Video file]. Retrieved from https://youtu.be/1NO5BAqsYGk CC BY license.

COs cognitive level and mapping with PSOs:

PGM4504CM NUMBER THEORY AND CRYPTOGRAPHY							
CO	**COGNITIVE LEVEL**	**PSO**					
		1	**2**	**3**	**4**	**5**	**6**
CO1	K- 2 Understand	3	1	2	3	2	3
CO2	K- 2 Understand	3	1	2	3	2	2
CO3	K- 6 Create	3	1	2	3	1	2
CO4	K-2 Understand	3	3	2	3	2	3
CO5	K-3 Apply	3	3	2	3	2	3

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)