M.Sc. Mathematics Syllabus Lecture wise plan for the academic year 2017-2018
Course: M.Sc. Mathematics
Year& Semester: I Year I Semester
Subject: Algebra, Paper: I (MM 101)
Text Book: Basic Abstract Algebra by P.B.Bhattacharya, S.K.Jain, S.R.Nagpaul.

Lecture No	Learning Objectives	Topics to be covered	Remarks
1	UNIT-I Chapter-5(Pages 104 to 128) 1. Normal subgroups	Introduction, normal subgroups, derived subgroup, theorem 1.4 and examples	
2	2. Isomorphism theorems	Theorem 2.1(1st Isomorphism theorem), corollary2.2, theorem 2.3, theorem 3.4 (2^{nd} and 3^{rd} isomorphism theorems).	
3		Theorem 2.5, theorem 2.6 (correspondence theorem), corollary 2.7, maximal normal sub groups, corollary 2.8, 2.9 and examples 2.10.	
4	3. Automorphisms	Automorphism of G, Inner automorphism of G and the groups Aut(G), In(G), Theorem 3.1, In(G)$\lhd$ $Aut(G). and\ \frac{G}{Z(G)} \cong In(G).$	
5		Examples 3.2(a), 3.2(b), 3.2(c) 3.2(d) 3.2(e).	
6	4.Conjugacy and G-Sets	Definition of group action, G-set, Examples of G-Sets 4.1.	
7		Theorem 4.2, theorem 4.3(Cayley's theorem), faithfull representation, theorem 4.4	
8		Corollary 4.5, Corollary 4.6, Stabilizer, Orbit, Conjugate class, theorem 4.7, theorem 4.8	
9		Theorem 4.8, 4.9 and 4.10, corollary 4.11, Burnside theorem 4.12 and examples.	
10	Chapter-6 Normal series 1. Normal series	Normal series, Composition series, Lemma 1.1, examples 1.2, equivalent normal series.	
11		Theorem1.3(Jordan-Holder theorem).Examples 1.4: (a), (b), (c), (d)	
12	2. Solvable groups	nth derived group, solvable group, theorem 2.1.	
13		Theorem2.2, examples 2.3, introduction of nilpotent groups	

14	3. Nilpotent groups	Definition of $Z_n(G)$, Upper central series, nilpotent group, theorem 3.1, theorem 3.2.	
15		Corollary 3.3, the converse of corollary 3.3, theorem 3.4 and theorem 3.5.	
16	UNIT-2 Chapter-8(Pages 138 to 155) Structure theorems of groups. 1.Direct Products	Introduction, theorem 1.1, equivalent statements,	
17		Internal direct product, internal direct sum of subgroups of G, Examples 1.2.	
18	2. Finitely generated abelian groups	Theorem 2.1, fundamental theorem of finitely generated abelian groups.	
19		Proof of theorem 2.1(fundamental theorem of finitely generated abelian groups)	
20	3. Invariants of finite abelian groups.	Theorem 3.1, Invariants of a finite abelian group, the partitions of a number e., the set of partitions of e , P (e). lemma3.2.	
21		Lemma 3.3, Theorem 3.4 and example 3.5	
22	4. Sylow theorems	Introduction, definition of Sylow p sub group and p- group, Lemma4.1 (Cauchy's theorem for abelian groups).	
23		Theorem 4.2, First Sylow theorem, Corollary 4.3, Cauchy's theorem.	
24		Corollary 4.4, A finite group is a p-group iff its order is a power of p, theorem 4.5.	
25		Proof of the Theorem 4.5(second and third Sylow theorem)	
26		Corollary 4.6(A Sylow p-sub group of a finite group is unique if and only if it is normal, Examples 4.7(a), (b)(the converse of the Legranges theorem.	
27		Example 4.7(c), groups of order 63, 56 and 36 are not simple. Example 4.7(d)	
28		Example 4.7(e), 4.7(f)(group of order pq, where p and q are primes such that $p > q$ & $q \nmid p-1$ is cyclic.group of order 15 is cyclic.	
29		Example 4.7(h), There are only two nonabelian groups of order 8	

30	5. Groups of orders p^2, pq.	5.1. Groups of orderp^2, 5.2. Groups of order $pq, q > p$.(There are only two groups of order pq)	
31	UNIT III Chapter-10(Pages 179 to 210)	Introduction of Rings	
32	Ideals and Homomophisms	Introduction and examples of Ideals	
33		Theorems on properties of Ideals	
34	Homomorphisms	Introduction and examples of homoorphisms	
35		Theorems on properties of homomorphisms	
36	Sums and direct sums of Ideals	Definition and examples of Sums and Direct sums	
37		Properties of Sums and Direct Sums	
38	Maximal and prime Ideals	Introduction and Definition of Maximal Ideal and Prime Ideals	
39		Theorems on necessary and sufficient conditions of Maximal Ideal and Prime	
40		Properties of Maximal and Prime and Principal Ideal	
41	Nilpotent and nil Ideals	Definition and examples of Nilpotent Ideal and Nil ideals	
42		Properties of Nilpotent ideal and nil ideal	
43		Theorems and applications of Nilpotent ideal and nil ideal	
44	Zorn's lemma	Introduction of Zone's lemma	

45		State and proof of Zorn's lemma	
46	Unit IV Chapter 11(page no 212 to 224)	Introduction of domains	
47	UFD	Introduction of Unique factorisation	
48		Definition and examples of UFD	
49		Theorems on UFD	
50	PID	Definition and examples of PID	
51		Theorems on PID	
52		Theorems on PID	
53		Applications of PID and UFD	
54	Euclidean domains	Definition and examples of Euclidean domain	
55		Theorems on Euclidean Domain	
56	Polynomial rings	Definition and examples of polynomial rings	
57		Theorems on polynomial rings	
58	Ring of fractions	Introduction of fractions	

59		Definition and applications of Ring of fraction	
60		Properties of ring of fractions	

Subject: Real Analysis Paper: II (MM 102)
Text Book: Principles of Mathematical Analysis. By W.Ruddin

Lecture No	Learning Objectives	Topics to be covered	
1	Unit-I Metric Spaces	Definition of Metric space, Problems	
2		Definitions of nbd point, Interior point, Open set, Every nbd is an open set, Compliment of a set, Union, finite intersection of open sets is open	
3		Int(E), $Int(E) = \bigcup N_r(P)$, Int(E) is an open subset of E,E is open iff Int(E)=E, Limit point, Closed set, limit point implies its nbd contains infinitely many points.	
4		E is open iff its compliment is closed, E is closed iff its complement is open, Finite Union, intersection of closed sets is closed.	
5		Derived set, closure of a set, Dense set,Colsure of E is closed, E is closed iff $E = \overline{E}$,E is bdd below y=Sup(E) then $y \in \overline{E}$	
6	Compact sets	Open cover, Finite sub cover, Compact set Theorem on K is compact relative to X iff K is compact relative to Y, Compact subsets of a Metric spaces are closed	
7		Closed subsets of Compact sets are compact, F is closed and K is compact then $F \bigcap K$ is compact, FIP, $K_n \supset K_{n+1}$ $then \bigcap K_n$ is non empt	
8		If E is infinite sub set of compact set K then E has a limit point in K,	
9		Theorem on every k-cell is compact	
10		Heine borel theorem, Weierstrass theorem	
11	Perfect sets	Perfect set, Cantor set, Cantor set is non empty, closed, compact, perfect set	
12		Every non empty perfect set is countable	
13	Connected sets	Separable sets, Connected set, Disconnected set exemples	
14		E is a sub set of R, E is connected iff it is an interval	
15		Revision on Unit I	
16	Unit –II Limits of functions	Limit of a function, Theorem on , $\underset{x \to p}{Lt} f(x) = q \Leftrightarrow \underset{n \to \infty}{Lt} f(p_n) = q$, Limit is unique, Properties	

		on limits	
17	Continuous functions	Cintinuous function, composition of continuous function is continuous, problems	
18		$f : X \to Y$ is continuous iff $f^{-1}(V)$ is open in X for every V is open in Y	
19		$f : X \to Y$ is continuous iff $f^{-1}(C)$ is closed in X for every C is closed in Y, f+g,f-g,fg and f/g are continuous,	
20		Theorem on $F(x) = (f_1, f_2, ... f_k)$ if F is continuous iff each f_k is continuous	
21	Continuity and compactness	The continuous image of compact set set is compact,	
22		f is continuous then f(X) is closed and bounded,	
23		If f is continuous on compact set then it exists inf and sup,	
24		f is continuous on compact set then its inverse is continuous	
25		Uniform continuous function,	
26		Theorem on a continuous function defined on compact metric space is uniformly continuous	
27	Continuity and connectedness	The continuous image of a connected set is connected, Intermediate value theorem	
27	Discontinuities	Definition of limit, Discontinuity, Types of discontinuity, Problems	
28	Monotonic functions	Definition of monotonic function, Theorem on monotonic function	
29		If f is monotonic on (a,b), the set of points at which f is discontinuous is at most countable	
30		Revision on Unit II	
31	Unit-III Existence of the Riemann stieltjes integral	Definition of Riemann stieltjes integral, $L(p, f, \alpha)$ and $U(p, f, \alpha)$, If p* is refinement of P then $L(p, f, \alpha) \le L(p^*, f, \alpha)$ $U(p^*, f, \alpha) \le Up, f, \alpha)$	
32		Necessary and sufficient condition , Every continuous function is Riemann stieltjes integral	
33		Every monotonic function is Riemann stieltjes integral, Theorem on f is discontinuous finite points of [a,b] then f is Riemann stieltjes integral	
34	Proporties of Riemann stieltjes integral	$f_1, f_2 \in R(\alpha)$ then $f_1 + f_2 \in R(\alpha)$ $cf \in R(\alpha)$	
35		$f_1, f_2 \in R(\alpha)$ If $f_1 \le f_2$ $then \int_a^b f_1 d\alpha \le \int_a^b f_2 d\alpha$, $f \in R(\alpha)$ If $a < c < b$ $then$ $f \in R(\alpha)$ on $[a, c]$ and $[c, b]$	

36		$\left\|\int_a^b fd\alpha\right\| \le M[\alpha(b)-\alpha(a)$, $f \in R(\alpha_1), f \in R(\alpha_2)\ then\ f \in R(\alpha_1+\alpha_2)$ $f \in R(\alpha)\ \ then\ f \in R(c\alpha)$	
37		$f \in R(\alpha), g \in R(\alpha)\ \ then\ fg, \|f\| \in R(\alpha)$,theorems on unit step function, Change of variable	
38	Integration and Differentiation	$f \in R(\alpha), F = \int_a^x f(t)dt$ then F is continuous and differentiable	
39		Fundamental theorem of Integral calculus, Integration by parts	
40	Integration of Vector valued functions	Definition of vector valued function $f \in R(\alpha)\ F = \int_a^x f(t)dt$	
41		Theorem on vector valued functions	
42	Rectifiable curves	Curve in R^k, Length of a curve, Rectifiable curve,	
43		Theorem on $\mathrm{A}(\gamma) = \int_a^b \left\|\gamma^1(t)dt\right\|$	
44		Revision of Unit-III	
45	Unit-IV Sequences and series of functions	Point wise convergence, examples,	
46	Uniform convergence	Uniform convergent, Cauchy criterion for uniform convergence	
47		Weirstrass M-test, problems	
48	Uniform convergence and Continuity	Theorem on $\underset{t\to x}{Lt}\ \underset{n\to\infty}{Lt}\ f_n(t) = \underset{n\to\infty}{Lt}\ \underset{t\to x}{Lt}\ f_n(t)$	
49		Theorem on suppose K is compact and $\{f_n\}$ is a continuous and converges point wise on K, $f_n(x) \ge f_{n=1}(x)$ then $f_n \to f$ uniformly on K	
50		Definition of $C(X)$, Supremum norm, $C(X)$ is a metric space, Convergent, Cauchy sequence in $C(X)$	
51		$f_n \to f$ iff $f_n \to f$ uniformly on X w.r.t $C(X)$	
52		$C(X)$ is a complete metric space	
53	Uniform convergence	Theorem on Uniform convergence and Integration	

	and Integration		
54		Corollary on Uniform convergence and Integration	
55	Uniform convergence and differentiation	Theorem on Uniform convergence and differentiation	
56		Theorem on continuous function on the real line which is no where differentiable	
57	Approximation of a Continuous functions by a sequence of polynomials	The Stone Weierstrass theorem	
58		The Stone Weierstrass theorem	
59		Revision on Unit -IV	
60		Pre final exam	

Subject: Discrete Mathematics, Paper: III (MM 103)

Text Book: Elements of Discrete Mathematics by CL. Liu

	Learning Objectives	Topics to be covered	
1	UNIT-I Set Theory and Lattices	Introduction, Definitions of Cartesian Product of two sets and Relation, types of relation, Equivalence relation, Partial Order, Partial Order Set, Total Order , Total Order Set (or) Chain with examples	
2	Hesse Diagram of a set	Definition, theorem with examples	
3		Problems on Drawing of Hesse Diagram	
4		Least Element and Greatest Element in Partial Order Set with examples, a chain will contain the Least and Greatest elements in partial order set.	
5	Dual of a Partial Order Set	Definition, Lemma: Dual of a Partial Order Set is Partial Order Set.	
6	Minimal and Maximal Elements in a Partial Order Set	Definitions with examples, Upper and Lower Boundary of a set in a Partial Order Set with examples.	
7		Problems on Lower bounds and Upper bounds	

8		Least Upper Bound (LUB) & Greatest Lower Bound (GLB) with examples, problems, Well Ordered Set, Theorem: Every Well-Ordered Partial Order Set is Chain.	
9	LATTICE	Definition with example , theorem: Every Chain is a Lattice, Principle of Duality, Theorem: Let (L,≤) is a Lattice for any a,b€L Then a≤biff a*b = a iffa+b=b	
10		Theoremso on IsotonicityProperty, Distributive Laws, Modular Inequality with remarks.	
11		Lattices as Algebraic Structure , Theorem: Show that (L,R) is Lattice with respect to Order R.	
12	Sub Lattices	Definition with example, problems, Definition of Interval in a Lattice, Theorem: Every Interval in a Lattice is a Sub Lattice.	
13	Direct product of Lattices	Definition of Direct product of Lattices with examples , Theorem: The Direct Product of two Lattices is a Lattice.	
14	Lattice Homomorphism	Definition, theorem Lattice Homomorphism, Isomorphism of Lattices, Endomorphism(or) Automorphism, Theorem: If g:L—›L is an endomorphism then g(L) is Sub lattice of L.	
15		Order preserving, Order Isomorphic, theorem: Every finite subset of a lattice L has least upper bound and greatest lower bound in L. Complete Lattice: Definition, theorem: Every finite Lattice is Complete. Theorem: Every complete lattice has greatest and least element. Bounded Lattice, complemented Lattice, Theorem: Every Chain is a Distributive Lattice	
16	UNIT-II Boolean Algebra	Definition of Boolean Algebra and its properties with examples	
17		Degenerated Boolean Algebra: - Generalized laws, Generalized Distributive Laws, Generalized Demorgans Law with theorems.	
18	Sub Algebra	Definition and theorems of Sub Algebra, Direct product of Boolean Algebra,Boolean Homomorphism with theorem	
19		Join irreducible element in a lattice with examples and theorem, Atom with examples, Problems on sub algebra.	
20	Boolean Expression	Definition with a note, Equivalence of Boolean Expression with example, Min terms in n-	

		variables(2-variable, 3-variable) , sum of product of Canonical form, problems on Boolean expressions.	
21		Maximum Term (or) Complete Sum (or) Fundamental Sum with example , value of Boolean Expression with problems	
22		Problems on the value of Boolean Expressions, Sum of Product, Free Boolean Algebra	
23	Stone Representation Theorem	Statement and proof of the Stone Representation Theorem	
24		2nd part proof of the Stone Representation Theorem	
25		Boolean Function, Pairwise Symmetric and Symmetric with examples and problems	
26	Karnaugh map method	`1-Variable Karnaugh map, 2-Variable Karnaugh map, 3-Variable Karnaugh map with minimizing	
27		Problems on Karnaugh Map with 1-variable	
28		Problems on Karnaugh Map with 2-variable	
29		Problems on Karnaugh Map with 3-variable	
30		Exercise problems	
31	UNIT-III Graph Theory	Definition of Graph, Types of Graphs with examples and notes	
32		Finite Graph, Simple Graph, Self loop(Sling) Multi Graph and Degree of a Vertex with examples	
33		In degree and Out Degree of a Directed Graph with examples, theorem: The sum of degrees of all vertices in any non-directed graph is always twice the number of edges.	
34		Theorem: The number of odd degree vertices in any non-directed graph is always even., theorem on Directed Graph	
34		Adjacency of Vertices, Adjacency of Edges, complete Graph K-regular graph with examples, theorem on K-regular Graph, Degree Sequence of a Graph with examples.	
35	Isomorphism of Graphs	Definition and Necessary conditions, Isolated node, Null Graph,	

36		Problems on Isomorphic of graphs, Isolated vertex, Pendent vertex with examples	
37		Problems onIsomorphic of graphs,	
38		Problems on Isomorphic of graphs,	
39	Sub Graph	Definition and examples, Complement of a Graph with examples , Multi graph and Weighted Graphs(Directed) and Path with examples	
40		Length of the Path, Simple Path, Elementary Path , Circuit (or) Cycle, Simple Circuit with examples and Elementary Circuit, Acyclic, connected and disconnected graph , Eulerian paths and circuits with examples	
41		Hamiltonian path & Hamiltonian Circuits with examples, problems on Hamiltonian Circuit	
42	Shortest Path	Procedure of Shortest Path (Dijkstra's Algorithm) and problems on Shortest Path	
43		Special Graphs, Planner Graphs& Non-Planner Graphs with examples,	
44		Problems on Planner Graphs & Non-Planner Graph.	
45	Euler Formula	Definition, theorems and problems on Euler Formula **(v-e-r=2)**	
46	UNIT-IV Trees and Cut Sets	Introduction, Definition of Tree and Types of Tree with examples, Branch Node, Directed Tree and Rooted Tree with examples	
47		M-ary Tree , Ordered Tree, Degree of a Directed Tree and Path Length in a Rooted Tree with examples	
48		Height of a Tree, Regular m-arry Tree with examples , Properties of Trees(as theorems)	
49	Spanning Tree	Definition with example, Theorem: A Circuit and complement of any spanning tree must have at least one edge in common with example.	
50		Binary Tree, Binary Search Tree with examples, Regular Binary Tree , Weight of a Binary Tree with example	

51		Problems on finding of minimal spanning tree with minimal weight using Kruskals Algorithm	
52	Optimal Tree	Definition and problems on construction of Optimal Tree with example	
53	Prefix Code	Definition and examples and Problems on Prefix Code	
54	Cut Sets	Definition of Cut Set with examples and Conditions	
55		Theorem: A Cut Set & any spanning Tree must have at least one edge in common with examples.	
56		Problems on Cut Sets& Spanning Trees	
57		Problems on Cut Sets	
58		Theorems on Cut Sets	
59		Theorems on Spanning Trees	
60		Exercise problems	

Subject: Elementary Number Theory, Paper: IV (MM 104)
Text Book: Introduction to Analytic Number Theory by Tom. M. Apostol. Chapters: 1,2,5,9

Lecture No	Learning Objectives	Topics to be covered	Remarks
1	UNIT-1 1. The fundamental theorem of Arithmetic	Introduction of numbers, the principal of Induction, the well ordering principle	
2		Divisibility, examples , divisibility properties theorem 1.1	
3	Greatest Common Divisor	Divisor , common divisor, Theorem 1.2, theorem 1.3	
4		Greatest common divisor, theorem 1.4 (properties of the gcd)	
5	prime numbers	Theorem 1.5(Euclid's lemma), prime numbers, theorem 1.6(Every integer $n > 1$	

		is either a prime number or product of primes.), theorem 1.7(Euclid's theorem)	
6		Theorem 1.8, theorem 1.9 and its applications	
7	The fundamental theorem of arithmetic	The fundamental theorem of arithmetic, theorem 1.10, theorem 1.11. Examples and applications.	
8		Theorem 1.12, problems on fundamental theorem of arithmetic.	
9		The series of reciprocal of primes , theorem 1.13	
10	The division algorithm theorem	The division algorithm theorem 1.14, applications.	
11		The Euclidean algorithm theorem 1.15 and its applications	
12		Problems for finding GCD by using Euclidean algorithm	
13		The greatest common divisor of more than two numbers and its properties.	
14		Exercises for chapter 1	
15		Exercises for chapter 1	
16	UNIT-2 Chapter 2 Arithmetic functions	Introduction, definition of arithmetical function, examples.	
17		The Mobius function $\mu(n)$, values of $\mu(n)$ at different numbers, theorem 2.1	
18		The Euler totient function $\phi(n)$, theorem 2.2, a relation connecting ϕ and μ. Theorem 2.3	
19		The product formula for $\phi(n)$, theorem 2.4.	
20		Theorem 2.5, properties of $\phi(n)$.	
21	The Dirichlet product of arithmetical functions	The dirichlet product of arithmetical functions, theorem 2.6, dirichlet product of arithmetical functions is commutative and	

		associative.	
22		The arithmetical function I(n), theorem 2.7, $I * f = f = f * I$, theorem 2.8 dirichlet inverse.	
23		The unit function u(n), theorem 2.9, Mobius inversion formula, and its applications	
24		The Mangoldt's function $\wedge(n)$, examples, theorem 2.10, $if\ n \geq 1 \Rightarrow log n = \sum_{d/n} \Lambda(d)$.	
25		Theorem 2.11, multiplicative and complete multiplicative functions, examples and its properties.	
26		Theorem 2.12, theorem 2.13, multiplicative functions and dirichlet multiplication theorem 2.14.	
27		Theorem 2.15 and theorem 2.16	
28		The inverse of a completely multiplicative function theorem 2.17, theorem 2.18.	
29		Liouville's function $\lambda(n)$, examples and theorem 2.19	
30		The divisor function $\sigma_\alpha(n)$, examples, Theorem 2.20and its applications.	
31	UNIT-III Chapter 5 Congruences	Definition and basic properties of congruences, theorem 5.1, theorem 5.2, examples.	
32		Theorem 5.3, Theorem 5.4, Theorem 5.5, Theorem 5.6	
33		Theorem 5.7, Theorem 5.8, Theorem 5.9.	
34		Residue classes and complete residue system, theorem 5.10, Theorem 5.11.	
35	Linear congruences	Linear congruences, examples, properties, Theorem 5.12, Theorem 5.13.	
36		Theorem 5.14, Theorem 5.15.	
37	Reduced residue system and Euler Fermat theorem	Definition of RRS and examples, Theorem 5.16, Theorem 5.17(Euler Fermat theorem).	
38		Theorem 5.18, Theorem 5.19(Little Fermat	

		theorem), Theorem 5.20, examples.	
39	Polynomial congruences modulo p	Polynomial congruences modulo p, Theorem 5.21, Lagranges theorem.	
40		Applications of Lagranges theorem, Theorem 5.22, Theorem 5.23, Theorem 5.24 (Wilsons theorem).	
41		Converse of Wilsons theorem, theorem 5.25 (Wolstenholme's theorem.).	
42	Simultaneous linear congruences	Introduction, theorem 5.26 (Chinese Remainder theorem), applications and problems.	
43		Theorem 5.27, problems	
44	Applications of chinese remainder theorem	Applications of Chinese remainder theorem, theorem 5.28, theorem 5.29.	
45	Polynomial congruences with prime power moduli.	Polynomial congruences with prime power moduli Theorem 5.30, applications and problems.	
46	UNIT-IV(Chapter-9) Quadratic residues and the Quadratic Reciprocity law	Introduction, Quadratic residues and Quadratic non residues and examples, Theorem 9.1.	
47		Definition of Legendre's symbol examples	
48		Properties of Legendre's symbol.	
49		Theorem 9.2, Euler's criterian for finding Legendre's symbol.	
50		Theorem 9.3, Legendre symbol $(^{n}/_{p})$ is a CMF and Evaluation of $(^{-1}/_{p})$ and $(^{-2}/_{p})$.	
51		Theorem 9.4 and theorem 9.5 and problems.	
52		Theorem 9.6 (Gauss lemma).	
53		Proof of gauss lemma and theorem 9.6.	
54		Theorem 9.7 (determining the parity of m in the Gauss lemma).	
55	The Quadratic reciprocity law	Theorem 9.8(The Quadratic reciprocity law).	

56		Proof of The Quadratic reciprocity law	
57		Applications of the The Quadratic reciprocity law	
58		Example problems, Evaluation of Legendre's symbols$\left({}^{219}/_{383}\right)$ and $\left({}^{888}/_{1999}\right)$	
59		Evaluation of $\left({}^{127}/_{17}\right)$ and other examples for finding Legendre's symbol.	
60		Problems for finding Legendre's symbol.	

Subject: Mathematical methods

Paper: V (MM 105)

Text Book: Elements of Partial Differential Equations by Ian Sneddon

Lecture No	Learning Objectives	Topics to be covered	
1	Unit I Introduction of PDE	Definition of PDE, examples with applications	
2	Formulation of PDE	Formulation of PDE CaseI	
3		Formulation of PDE CaseII	
4		Formulation of PDE CaseIII	
5	Finding the arbitrary functions	Procedure of finding the arbitrary functions of PDF	
6		Exercise problems of Finding the arbitrary functions of PDF	
7	Solutions of PDE	Method I: procedure and exercise problems	
8		Method II: procedure and exercise problems	
9		Method III and IV: procedure and exercise problems	
10	Charpit's method	Derivation of Charpit's auxiliary equation	
11		Solution (C.F &P.I)PDE by Charpits method- case I	
12		Solution (C.F &P.I)PDE by Charpits method- case II	
13		Solution (C.F &P.I)PDE by Charpits method- case III	
14		Solution (C.F &P.I)PDE by Charpits method- case IV	

15		Finding the singular integral of PDE	
16	UINT II Second order PDE	Introduction of second order PDE and example	
17		Formulation of second order PDE	
18		Special cases of second order PDE – hyperbolic, parabolic and Elliptic equations	
19	Solutions of second order PDE	Case I &II of finding the solution of second order PDE	
20		Case III & IV of finding the solution of second order PDE	
21	Canonical form of second order PDE	Introduction and derivation of canonical form of second order PDE	
22		Case I: finding the canonical form of second order PDE	
23		Case II: finding the canonical form of second order PDE	
24	Heat equation	Derivation of one dimensional heat equation	
25		Derivation of two dimensional heat equation	
26		Finding the solution of Heat equations	
27	Wave equation	Derivation of one dimensional wave equation	
28		Derivation of Two dimensional wave equation	
29		Finding the solution of wave equations	
30		Exercise problems on PDE	
31	UNIT III Power series solutions	Introduction of power series solutions of Differential equations	
32		Regular points, singular points &irregular singular points of Differential equations and exercise problems	
33		Finding the power series solutions of differential equations	
34		Finding the power series solutions of differential equations- Case I & case II	
35		Frobnies method - Finding the power series solutions of differential equations	
36	Legender Polynomial	Introduction and finding the series solution of Legendre equation	
37		Recurrence relations and proofs of Legendre polynomial	

38		Generating function and proof of Legendre polynomial	
39		Finding the some polynomial of Legendre polynomial	
40		Orthogonal property of Legendre polynomial	
41		Some properties of Legendre polynomial	
42		Rodrigue's formula for Legendre polynomial	
43		Applications of Rodrigue's formula	
44		Applications of recurrence relations of Legendre polynomial	
45		Some exercise problems of Legendre equation.	
46	UINT IV Bessel's equations	Introduction and derivation of power series solution of Bessel's equation	
47		Recurrence relations of Bessel's polynomial and some applications	
48		Generating function and proof of Bessel's polynomial	
49		Orthogonal property of Bessel's polynomial	
50		Derivation of applications and some polynomials of Bessel's polynomial	
51		Some important of results of Bessel' s polynomial	
52		Exercise problems on applications of Bessel' s polynomial	
53	Hermit' equation	Introduction and derivation of power series solution of Bessel's equation	
54		Recurrence relations of Bessel's polynomial and some applications	
55		Generating function and proof of Bessel's polynomial	
56		Derivation of applications and some polynomials of Bessel's polynomial	
57		Some important of results of Bessel' s polynomial	
58		Orthogonal property of Bessel's polynomial	
59		Exercise problems on applications of Bessel' s polynomial	
60		Revision	

M.Sc. Mathematics Syllabus Lecture wise plan for the academic year 2017-2018
Course: M.Sc. Mathematics
Year& Semester: I Year II Semester

Subject: Advanced Algebra, Paper: I (MM 201)
Text Book: Basic Abstract Algebra by P.B.Bhattacharya, S.K.Jain, S.R.Nagpaul

Lecture No	Learning Objectives	Topics to be covered	Reamarks
1	UNIT-I Chapter-15(Pages 281 to 299) Algebraic Extension Of Fields, 1. Irreducible polynomials and Eisenstein criterion	Introduction, Review of previous results Definitions of Reducible and Irreducible polynomials. And Properties of F[x].	
2		Proposition 1.2, zero of a polynomial, Proposition 1.3, content of a polynomial, primitive and monic polynomials.	
3		Lemma 1.4, Gauss lemma 1.5, Lemma 1.6	
4		Theorem 1.7, Theorem1.8(Eisenstein criterion), examples 1.9	
5		Problems, based on reducibility and irreducibility.	
6	2. Adjunction of Roots	Extension field, degree of an extension, and theorem 2.1, lemma 2.2	
7		Theorem2.3, Corollary2.4(Kronecker theorem), theorem 2.5	
8		Examples 2.6 and problems based on adjunction of roots	
9	3. Algebraic extensions	Defination of algebraic and transcendental element, theorem 3.1, minimal polynomial, algebraic and transcendental extensions.	
10		theorem3.2, theorem 3.3, examples 3.4, finitely generated field	
11		Example 3.5, theorem 3.6, theorem 3.7, F- homomorhism and F-embedding	
12		Theorem 3.8, problems	
13	4. Algebraically closed fields	Definition of algebraically closed field, theore 4.1, Algebraic closure of a field F, Lemma 4.2.	
14		Theorem 4.3, theorem 4.4, Polynomial ring over F in S, F[S].	
15		Theorem 4.5, theorem 4.6, closure of R is C	

16	Unit-II Chapter-16(Pages 300 to 321) (Normal and Separable extensions) 1. Splitting fields	Splitting fields, theorem 1.1, theorem 1.2 (Uniqueness of splitting field)	
17		Examples 1.3(a), 1.3(b), 1.3(c), problems	
18	2. Normal extensions	Definition of Normal extension, Theorem 2.1(Equivalent statements of normal extensions)	
19		Examples of normal extensions 2.2(a), 2.2(b), 2.2(c), Example 2.3 and problems.	
20	3. Multiple roots	Definition of a derivative of f(x), theorem 3.1, theorem 3.2, Simple root, Multiple root, multiplicity of root	
21		Theorem 3.3,corollary 3.4, corollary 3.5	
22		Theorem 3.6, corollary 3.7, example 3.8 and problems.	
23	4. Finite fields	Prime field, theorem 4.1, theorem 4.2, Galois field	
24		Theorem 4.3theorem 4.4, theorem 4.5	
25		Theorem 4.6(The multiplicative group of nonzero elements of finite field is cyclic), corollary 4.7, theorem 4.8, examples 4.9(a), 4.9(b)	
26		Examples 4.9(c), 4.9(d), problems.	
27	5. Separable extensions	Separable polynomial, separable element, separable extension, remark 5.1, perfect field, simple extension , theorem 5.2	
28		Theorem 5.2, theorem 5.3	
29		Examples 5.4(a), 5.4(b)	
30		Examples 5.4(c), problems.	
31	UNIT-III Chapter-17(Pages 322 to 339) Galois theory 1.Automorphism groups and fixed fields	Group of Automorphisms, Group of F-Automorphisms.	
32		Theorem 1.1, examples 1.2(a), 1.2(b) Fixed field of the group E_H	

33		Theorem1.3 $[E: E_H] = \|H\|$, Dedekind lemma 1.4	
34		Proof of the Theorem1.3 $[E: E_H] = \|H\|$	
35		Theorem1.5, Theorem1.6.Examples 1.7(a), 1.7(b), problems.	
36		Examples 1.7(a), 1.7(b), problems.	
37	2. Fundamental theorem of Galois theory	Galois group of f(x), Galois extension, theorem 2.1(Fundamental theorem of Galois theory).	
38		Proof of fundamental theorem of Galois theorem.	
39		Examples 2.2(a), 2.2(b).	
40		Examples 2.2(c), 2.2(d).	
41		Examples 2.2(e), Examples 2.2(f)	
42		Examples 2.2(g), 2.2(h)	
43	3. Fundamental theorem of Algebra	Applications of Galois theory to the field of Complex numbers, theorem 3.1(fundamental theorem of Galois theory)	
44		Proof of the fundamental theorem of Galois theory.	
45	UNIT-IV, Chapter-18(Pages 340 to 364) Applications of Galois theory to the Classical problems. 1. Roots of unity and cyclotomic polynomials.	n^{th} roots and primity n^{th} roots of unity The set of n^{th} roots of unity forms a multiplicative group, Theorem 1.1, theorem 1.2	
46		n^{th}Cyclotomic polynomial and finding cyclotomic polynomials for n=1, 2, 3,4,5,6.	
47		Theorem 1.3n^{th} cyclotomic polynomialis irreducible over C	
48		Theorem 1.4	
49		Examples 1.5(a), 1.5(b)	
50	2. Cyclic extensions	Definition of cyclic extension, examples of cyclic extensions 2.1(a), 2.1(b)	
51		Proposition 2.2 and lemma 2.3.	
52		Lemma 3.4, special case of Hilbert's	

		problem 90, theorem 2.5	
53		Proof of Theorem 2.5, problems	
54	3. Polynomials solvable by radicals	Definition of radical extension, examples and remark 3.1, theorem 3.2.	
55		Lemma 3.3, theorem 3.4, theorem 3.5	
56		Theorem 3.6, examples 3.7(a), 3.7(b) and problems.	
57	4. Symmetric functions	Introduction, definition, theorem 4.1, and examples4.2.	
58	5. Ruler and compass constructions	Introduction, definitions, theorem 5.1, theorem 5.2, lemma 5.3	
59		Lemma5.4, lemma 5.5, lemma 5.6 and lemma 5.7. Lemma 5.8, theorem 5.9, definition of an angle α is constructible, remark 5.10, examples 5.11.	
60		5.11(a) Problem of squaring a circle, 5.11(b) Problem of duplicating a cube, 5.11(c) Problem of trisecting an angle5.11 (d) Problem of constructing a regular n-gon, problems..	

Subject: Advanced Real Analysis, Paper: II (MM 202)
Text Book: Basic Real Analysis by H.L. Royden

Lecture No	Learning Objectives	Topics to be covered	
1	UNIT-I Algebra of Sets	Introduction, Algebra of Sets, Examples, Proposition 1&2, The Algebra generated by class of subsets of X and theorem.	
2		$\sigma - algebra\ of\ sets$ or Borel fields, Examples, theorem (the $\sigma - algebra$ generated by $\mathcal{C}., the\ class\ of\ Borel\ sets.$	
3		F_σ, G_δ Sets, Introduction of outer measure	
4	Outer Measure	Definition of Outer measure, Outer measure of singleton set is zero, $m^*(\emptyset) = 0, m^*(A) \leq m^*(B) \forall A \subseteq B.$	
5		Outer measure of an interval is its length and countable properties of outermeasure.	
6		Countable subadditive property, outer measure of countable set is zero, the interval [0,1] is uncountable, for $A \subseteq \mathbb{R}\ and\ \in > 0\ then\ \exists open\ set\ G, A \subseteq G\ and\ m^*(G) < m^*(A) + \in.$	
7		Lebesgue measurable sets, the $class\ \mathfrak{M}\ of\ measurable\ sets\ is\ a\sigma - algebra\ of\ sets.$	
8		Every Borel set is measurable, any closed set is measurable.	
9	Lebesgue measure	Definition of Lebesgue measure and countable sub additive property of Lebesgue measure.	
10		Little woods first principle and its equivalent forms and	

		applications.	
11	Existence of non-measurable set	Existence of non-measurable subset of [0,1] and measurable functions	
12		Equivalent statements of measurable functions, If f and g are measurable then f+c, cf, f+g, f-g and fg are measurable	
13		Let $\{f_n\}$ is sequence of measurable functions then Max$\{f_n\}$, min$\{f_n\}$, sup$\{f_n\}$, inf$\{f_n\}$,. $liminf\{f_n\} and\ limsup\{f_n\}\ are\ measurable.$	
14		f^+, f^- , almost everywhere (a.e) property, Charectaristic functionχ_E.and properties of χ_E and Little woods 2nd principle.	
15		Little woods 3rd principle and stronger version of the third principle.	
16	UNIT-II Riemann integral and Lebesgue integral	Introduction, step function and simple sunction	
17		Riemann integral and lebesgue integral of a simple function.	
18		Linear properties of Lebesgue integral of a simple function.	
19		Lebesgue integral of a bounded measurable function.	
20		Linear properties of Lebesgue integral of a boundedmeasurable function.	
21		Bounded convergence theorem	
22		Lebesgue integral of a non-negative measurable function and its properties.	
23		Fatous lemma.	
24		Monotone convergence theorem and its application (corollary).	
25		Non negative function which is integrable over a measurable set E.	
26		$f^+, f^-\ and\ \|f\|$and the integral of a measurable function and its properties.	
27		Linearity properties of integral of a measurable function	
27		Lebesgue (dominated) convergence theorem.	
28		Convergence in measure.	
29		Results (Theorems) based on Convergence in measure.	
30	UNIT-II Riemann integral and Lebesgue integral	Introduction, step function and simple sunction	
31	**Unit III** Convergence in Measure	Definitions of convergence in measure, Theorem on $If\ \ f_n \to f\ \ \ a.eonE\ withm(E) < \infty$ then f_n convergence in measure to f.	
32		Theorem on if f_n convergence in measure to f then there is a sub sequence f_{n_k} that convergence to f a.e.	
33	Differentiation of	Definition of Vitali cover, Vitali covering lemma	

	Monotone functions		
34		Vitali covering lemma, Dini derivatives, problems on dini derivatives	
35		Lebesgue Theroem	
36		Lebesgue Theroem	
37	Functions of Bounded variation	Definitions of Positive, Nagative, total variation and bounded variation	
38		Theorem on p-n= f(b) – f(a), p+n=t, If f is a bounded monotonic function on [a,b] then f is a bounded variation	
39		Every function of bounded variation is bounded, converse is noy true with example	
40		Every function of bounded variation need not be continuous, Every continuous function need not be bounded variation	
41		P-N= f(b)-f(a), P+N=T, sum of functions of bounded variation is bounded variation	
42		Jordan decomposition theorem	
43		If $f \in BV[a,b]$ then $f^{1}(x)$ exists a.e on [a,b]	
44		Problems on bounded variation	
45		Revision of Unit III	
46	**Unit IV** Differentiation and Integral	Definition of Indefinite integral, Lemma on Indefinite integral of f is continuous and function of bounded variation	
47		Theorem on if f is integrable on [a,b], and $\int_a^x f(t)dt = 0$ then f(t)=0 a.e on [a,b], if f is integrable on [a,b], and $F(x) = F(a) + \int_a^x f(t)dt = 0$ then $F^{1}(x) = f(x)$ a.e on [a,b]	
48	Absolutely Continuity	Definition of Absolute continuous, Lemma on If f is absolutely continuous on [a,b] then f is continuous on [a,b]. If f is absolutely continuous on [a,b] then $f^{1}(x)$ exists a.e on [a,b].	
49		If f is absolutely continuous on [a,b] and $f^{1}(x) = 0\ a.e$ exists a.e then f is constant.	
50		Theorem on a function F is an indefinite integral iff it is absolutely continuous.	
51	**L**^{p}- Spaces	Definition of **L**^{p}- Space, suppose $f:[0,1] \leftarrow R$ is defined as f(x)= C then $f \in L^{p}[0,1]$, $L^{p}[0,1]$ is a linear space, $L^{p}[0,1]$ is a Normed space	
52		Definition of Essential bound, Essential Supremum, Lemma on If f is bounded on [a,b] yhen f is essentially bounded but converse is not true, If f,g are measurable functions then $f \leq$ ess sup of f a.e and $ess\sup(f+g) \leq ess\sup f + ess\sup g$	
53		Definition of $L^{\infty}[0,1]$, it is a linear space and Normed space	
54	The Minkowski and Holder	Lemma on $\alpha^{\lambda}\beta^{1-\lambda} \leq \alpha\lambda + (1-\lambda)\beta$, Conjugate indeces	

	inequalities		
55		Holder inequality	
56		Minkowski inequality	
57	Convergence and Completeness	Definition of Series and partial sums, Summable, Absolute summable, Convergent, Cauchy sequence, Complete	
58		Theorem on Normed space X is complete iff every absolutely summable series is summable	
59		Riesz – Fischer Theorem	
60		Revision	

Subject: Functional Analysis, Paper: III (MM 203)
Text Book: Introductory Functional Analysis by E.Kreyszing

Lecture No	Learning Objectives	Topics to be covered	
1	Unit I Normed space, Banach space	Definitions of Normed space, Convegent sequence, Cauchy sequency, Banach space, Problems	
2		Examples on Normed and Banach spaces	
3	Further properties of Normed spaces	Sub space, Theorem on a sub space Y oa Banach space Xis complete iff Y is closed,Convergence of the series, Basis, Dense, Separable, Theorem on every Normed space with schauder basis is separable	
4		Isometric, Theorem on completion,	
5	Finite dimensional Normed spaces and subspaces	Theorem on $\|\alpha_1 x_1 + \alpha_2 x_2 + ... + \alpha_n x_n\| \geq C(\|\alpha_1 + \alpha_2 + ... + \alpha_n\|)$, Theorem on every finite dimensional normed space is complete	
6		Theorem on every finite dimensional subspace Y of a normed space X is closed, Theorem on equivalent norms	
7	Compactness and finite dimension	Compact set, Bounded set, Compact subset M of Metric space X is closed and bounded,M is a suvset of finite dimensional Normed space X is Compact iff M is closed and bounded	
8		Riesz lemma, Every closed unit sphere M of X is compact then X is finite dimensional, The image of compact set is compact under continuous mapping,	
9	Linear operators	Linear operator, R(T) and N(T) is Vector space, $Dim(D(T)) \prec \infty then\ DimR(T) \leq n$, Inverse operator, Theorem on Inverse operator, Inverse of product	
10	Bounded and Continuous linear operators	Bounded linear operator, Norm of an operator, Alternative formula for norm of operator, If X is finite dimensionevery linear operator on X is bounded	
11		Cintinuity of linear operator, T is continuous iff T is bounded, N(T) is closed, Theorem on $\|T_1 T_2\| \leq \|T_1\|\|T_2\|$	
12		Restriction and extension operators, Theorem on $\bar{T}$ is bounded and $\|\bar{T}\| = \|T\|$	

13	Linear functionals	Linear functional, Bounded, Norm of f, Algebric dual space, second algebraic dual space, f is continuous iff f is bounded	
14	Linear functional on finite dimensional spaces	If X is finite dimensional vector space then $\dim X^* = \dim X$, A finite dimensional vector space is Algebraically reflexive.	
15	Normed spaces of operators, dual space	$B(X,Y)$ is a Vector space, Normed space, If Y is a Banach space then $B(X,Y)$ is a Banach space, Dual space Dual spacve is a Banach space Dual space,	
16	**Unit II** Inner product space, Hilbert space	Definition of inner product space, Parallelogram law, Hilbert space,	
17		Problems on Inner product spaces	
18		Orthogonal, Pythagorean theorem, Appollonius identity, polarization identity	
19	Further properties of inner product spaces	Schwarz inequality, Triangle inequality	
20		Theorem on inner product is jointly continuous, Y is complete iff Y is closed,	
21		Theorem on Y is finite dimensional then Y is complete, If H is separable then Y is separable	
22	Orthogonal compliments and Direct sum	Definitions of distance feom a point to set, Segment, Convex, Theorem on minimizing vector, Theorem on if Y is covex complete sub space of X then x-y is orthogonal to Y	
23		Orthogonal compliment, Theorem on $\{0\}^{\perp} = H, H^{\perp} = \{0\}, S \cap S^{\perp} \subset \{0\}, if S_1 \subset S_2 then S_2^{\perp} \subset S_1^{\perp}, S \subset S^{\perp\perp}$	
24		Theorem on $Y^{\perp}$ is a closed linear sub space of H,Direct sum, Projection theorem	
25		Theorem on $Y^{\perp}$ is the null space, If Y is closed then $Y = Y^{\perp\perp}$, Span of M is dence in H iff $M^{\perp} = \{0\}$	
26	Ortho normal sets and Sequences	Definitions of Orthogonal set, Ortho normal set , Pythagorean relation, Ortho normal set is LI, Bessels inequality	
27		Gram-Schmidt Process, Problem	
27	Series related to ortho normal sequences	Theorem on convergence	
28		Theorem on any x in X can have at most countably many non zero fourier coefficients	
29		Lemma on fourier coefficients	
30		Revision on Unit II	
31	**Unit III** Total ortho Normal sets and sequences	Definitions of Total set, Total ortho normal set, Theorem on If M is total in X then $x \perp M \Rightarrow x = 0$, $If\ \ X\ is\ complete \Leftrightarrow x \perp M \Rightarrow x = 0$	

32		Theorem on an ortho normal set M is Total iff parseval relation holds, If H is separable then every ortho normal set in H is countable	
33		If H contains Total ortho normal set then H is separable,	
34		Theorem on two Hilbert spaces are isomorphic iff they are same dimension	
35	Representation of functional on Hilbert spaces	Riesz theorem ,	
36		Lemma on equality, sequilinear form	
37		Riesz representation theorem	
38	Hilbert Adjoint Operator	Definition of Hilbert Adjoint operator T^* , problems	
39		Theorem on T^* is unique,bounded linear operator and $\|T^*\| = \|T\|$, Lemma on zero operator	
40		Theorem on properties of Hilbert Adjoint operator	
41	Self adjoint, Unitary and Normal operators	Definitions of Self adjoint, Unitary and Normal operators, Theorem on self Adjointness	
42		Theorem on The product of two self adjoint operators is self adjoin tiff they are commute	
43		Theorem on sequence of Self adjoint operators	
44		Theorem on Unitary operator	
45		Revision of Unit III	
46	Unit IV Hahn- Banach Theorems	Definitions of Sublinear functional, Generalized Hahn-Banach Theorem	
47		Hahn –Banach theorem for Normed spaces	
48		Theorem on bounded linear functional, Norm and zero operator	
49	Adjoint Operator	Def. Adjoint Operator $T^\times$,Theorem on Norm of the Adjoint operator	
50		Relation between $T^* \text{ and } T^\times$	
51	Reflexive spaces	Definition of reflexive space, Lemma on $\|g_x\| = \|x\|$ Lemma on canonical mapping	
52		Theorem on every Hilbert space is reflexive, lemma on esistance of functional	
53		Theorem on separability	
54	Uniform Boundedness theorem	Definition of Category, , Baires category theorem	
55		Uniform Boundedness theorem	
56	Open mapping theorem	Def Open mapping , Open mapping theorem	
57	Closed graph theorem	Def: Closed linear operatoe,Product of two normed spaces is normed spacePeoperties of closed linear operatoe	
58		Closed graph theorem	
59		Revision of Unit IV	
60		Pre final exam	

Subject: Theory of Differential Equations Paper: IV (MM 204)

Text Book: Ordinary Differential Equations- Second Edition by S.G.Deo,V.Lakshmi Kantham, V.Raghavendra

	Learning Objectives	Topics to be covered	
1	UNIT-I Linear Differential Equations of Higher Order	Introduction, Definitions of Linear Independence and Linear Dependence with examples	
2		Problems on Linear Independence	
3		Problems on Linear Dependence	
4		Higher Order Equations $F(t,x,x^{I},x^{II},,,,,x^{n})=0$	
5		Equation with constant coefficients	
6		Problems on Equation with constant coefficients	
7		n^{th} Order Equations	
8		Theorems and problems on n^{th} Order Equations	
9		Problems on n^{th} Order Equations	
10		Theorems on Equations with Variable Coefficients	
11	Wronskian	Definition, theorems	
12	Abel's Lemma	Statement and proof	
13		Problems on Abel's Lemma	
14	Variation of Parameters	Theorems and problems	
15	Some Standard Methods	Method of Undetermined Coefficients and problems in three methods	
16	UNIT-II Existence and Unique of Solutions	Preliminaries, Definition on Lipschitz Condition and Theorem	
17		Problems and Remarks on Lipschitz Condition	
18	GronwallEnequvality	Statement and proof and problems	
19	Successive Approximation	Definition, theorem and problems	
20	Picard's Existence and Uniqueness Theorem	Statement and Proof	

21		Second Part of the Proof	
22		Theorems and Problems on Picard's Theorem	
23	Fixed Point Theorem	Definition of Fixed Point and theorem	
24	Contraction Mapping	Contraction Mapping theorem on Unique fixed Point	
25		Theorems and Problems on Continuation and Dependence on initial conditions	
26		Theorem and problems on Existence of solutions in the large	
27		Existence and Uniqueness of solutions of systems	
28		Lipschitz condition in systems and problems	
29		Lemma and problems on Existence and Uniqueness of solutions	
30		Exercise problems	
31	UNIT-III Analysis and Method of Non-Linear Differential Equations	Definition and theorem on Bihari's Inequality	
32		Theorem on Application of Bihari's Inequality	
33	Existence Theorem	Equvi continuous and Ascoli's Lemma	
34	Peano's Existence Theorem	Statement and Proof	
34	Extremal Solutions	Maximal solutions and Minimal solution	
35	Upper and Lower Solutions	Definitions and Theorems of Upper and Lower Solutions.	
36	Comparison theorem or Comparison Principle	Statement and Proof , Corollary	
37		Problems onComparison Principle	
38	Monotone Iterative Method & Method of Quasi Linerization	Statement and proof	
39		Second part proof of Monotone Iterative Method	
40		Problems on Monotone Iterative Method	
41		Problems on Monotone Iterative Method	
42		Problems on Method of Quasi Linearization	

43		Exercise problems	
44		Exercise problems	
45		Test conducted	
46	UNIT-IV Oscillation Theory for Linear Differential Equations	Introduction, theorems and Proof on Self adjoint Form	
47		Adjoint equation for 2nd Order Linear Differential Equations	
48		Theorems and Problems on 2nd Order Linear Differential Equations	
49		Problems on 2nd Order Linear Differential Equations	
50	Abel's Formula; Number of zeroes in a finite interval	Theorems on Abel's Formula	
51		Theorems on Abel's Formula	
52	Sturm- Separation Theorem	Statement and Proof	
53		Theorems and Problems on Sturm-Separation Theorem	
54		Lemma and examples on Sturm-Separation Theorem	
55		Problems on Sturm- Separation Theorem	
56	Sturm- Comparison theorem	Statement and proof	
57		Second part proof of the Sturm-Comparison theorem	
58	Sturm- Picone theorem	Statement and Proof	
59		Problems on Sturm- Picone theorem	
60		Exercise problems	

Subject: Topology **Paper: V (MM 205)**
Text Book: Topology and Modern Analysis by G.F.Simmons

Lecture No	Learning Objectives	Topics to be covered	
1	Unit I Introduction of Topolgy	Definition of Topolgy and examples	
2		Definition of Indiscrete Topolgy and Discrete Topology	

3		Definitions and Examples of open sets, closed sets, closure sets.	
4		Theorem on intersection of two topologies is again topology	
5		Prove that $\bar{E} = \{x \in E: every\ nbd\ of\ x\ intersect\ with\ E\}$	
6		Theorems on more properties of Topology	
7		Theorems on more properties of Topology	
8		Theorems on more properties of Topology	
9	Open base and open subbase	Definition of open base and open subbase with examples	
10		Theorems on open base	
11		Theorems on open subbase	
12	Continuous functions of two topologies	Definition of continuous function of between two topological spaces	
13		Examples of continuous functions	
14		Theorems on continuous functions	
15		Definition of Homeomorphism and examples	
16	Unit II Compactness of Topologies	Definition of open cover and open sub cover for topology	
17		Examples of open cover	
18		Definition and examples of compact topological space	
19		Theorems on properties of compactness of topological space	
20		Theorems on necessary and sufficient conditions of compact topological space.	
21		Definition of finite intersection property	
22		Properties of finite intersection property	
23	Basic open cover and sub basic open cover	Definition of Basic open cover and sub basic open cover and examples	
24		Theorems on Basic open cover and sub basic open cover	
		Definition of Bolzano-weirstrass property and basic applocations	
25		Definition of sequentially compact topological space and basic applocations	
26		Theorems on Bolzano-weirstrass property	
27		Theorems on sequentially compact topological space	
28		Equivalence properties of Bolzano-weirstrass property, sequentially compact and compact.	
29		Definition of diameter and labesgue number	
30		Labesgue covering lemma.	
31	Unit III Separation of topologies	definition and examples of T1 space, T2 space (Hausdorff space)	
32		Theorems on Hausdorff space applications	
33		Theorems on Hausdorff space applications	

34		Theorems on Hausdorff space applications	
35	Normal Space and Complete Normal Space	Definition of Normal topological space and examples	
36		Theorems on properties of Normal topological space	
37		Definition of Complete normal topological space and examples	
38		Theorems on properties of Complete normal topological space	
39		Theorems on comparison of separation of spaces	
40	Separation of closed set and compact space	Theorems on separation of point and compact space in Normal Space	
41		Theorems on separation of closed set and compact space in Normal space	
42		Tiertz's extension theorem with proof	
43		State and prove Urishon lemma	
44		State and prove Urishon Imbedding theorem	
45		Properties of complete normal topological space.	
46	UNIT IV Connectedness	Definition of separated sets, disconnected sets and connected sets	
47		Definition and examples of connected and disconnected topological spaces	
48		Definition and Maximal connected subsets of topological spaces	
49		Definition and examples of component in topological space	
50	theorems	Theorems on properties of connected topological space	
51		Necessary and sufficient condition of connected topological spaces	
52		Theorems on connected spaces	
53		Theorems on connected spaces	
54	Product Topological Spaces	Definition of Cartesian product ofsets	
55		Definition of Product Toplogical spaces	
56		State and prove Hein-Borel theorem and generalized Hein-Borel theorem	
57		State and prove Tyconoff's theorem	
58		Theorem on the product of compact topological spaces is compact	
59		State and prove product of connected topological spaces is connected	
60		revision	

M.Sc. Mathematics Syllabus Lecture wise plan for the academic year 2017-2018
Course: M.Sc. Mathematics
Year& Semester: II Year I Semester

Subject: Complex Analysis, **Paper: I (MM 301)**
Text Book: Complex Variable & Application 8th Edition by Jams Ward Brown,

Churchill McGrawhill International Edition

Msc Mathematics Syllabus Lecture wise plan for the academic year 2017-2018

Course: M.Sc. Mathematics

Year: II Year IV Semester

Subject: Complex Analysis,

Text Book: Complex Variable & Application 8th Edition by Jams Ward Brown, Ruel V.Churchill.

Paper: I

	Learning Objectives	Topics to be covered	
1	UNIT-I Complex Numbers	Introduction, Argand Plane (or) Z-plane Modulus of a Complex Plane, Properties of Complex Numbers, Conjugate of a Complex Number , properties of Conjugate.	
2		Polar form (or) Polar Co-Ordinates (or) Exponential ,Rules to find argument of Z	
3		Problems Polar form and modulus	
4	Regions in the Complex Plane	Neighbourhood (or) Circular Neighbourhood, Interior Point, Exterior Point , Boundary Point , Open set, Limit Point with examples	
5		Convex set, Connected set, Bounded set, Bolzano-Weistrass Theorem	
6		Domain and Region with examples, Function of Complex Variable with examples and Notes	
7	Limit of Complex	Definition and theorem on Limits: If the Limit of a function exists at a point it is Unique.	
8		Problems on limits and Limits involving the point at infinite	

9	Continuity	Definition with examples on Continuity and theorem	
10	Derivatives	Definition and example problems on Derivatives theorem: Every differentiable function is continuous	
11	Cauchy Riemann Equation	Statement and Proof of Cauchy Riemann Equation	
12		Cauchy Riemann Equations in Polar form and problems on Cauchy Riemann Equation	
13		Sufficient condition for Differentiation , theorem	
14		Problems on Cauchy Riemann Equations	
15		Problems on Cauchy Riemann Equation in polar form	
16	UNIT-II Analytical Functions	Definition of Analytical Functions and Entire Functions with examples, Properties of Analytical functions , verification of Analytical functions and problems	
17		Singular Point (Singularity), with examples	
18		Theorem: An analytic function in a region D where its derivative zero at every point of the domain is a constant.	
19		Theorem: An analytic function in a region with constant modulus in constant.	
20		Theorem: Any analytic function f(z)= u+iv with arg f(z) constant is itself constant a constant function .	
21		Theorems on compliment of complex functions	
22		Problems on analytical functions by using Cauchy Riemann equations	
23	Harmonic Functions	Definition and theorem: Real and Imaginary parts of analytic function are harmonic	
24		Definition of conjugate , theorem on Harmonic Conjugate	
25		Problems on harmonic conjugate by using C-R equations	
26	Milne-Thomson Method	Statement and proof of Milne-Thomson Method	

27	Elementary Function	Exponential function, Logarithmic Functions, Trigonometric Functions with examples	
28		Inverse Trigonometric and Hyperbolic functions with problems	
29		Reflection Principle , Theorem on Reflection Principle	
30		Exercise problems	
31	UNIT-III INTEGRATION	Derivative of function of w(t) , Definite Integrals of a function w(t), Piecewise Continuity with examples	
32		Contour, Simple arc (or) Jordan arc with examples, Piecewise Smooth with example	
33	Contour Integrals	Definition and problems on Contour Integrals	
34		Theorem on Upper bounds for Modulli of Contour Integrals	
34		Theorem on ML-Inequality	
35		Problems on Contour Integrals	
36	Anti-Derivatives	Definition with examples and problems	
37		Theorem on Anti-Derivatives	
38		2nd part proof of the theorem on Anti-Derivatives	
39		Problems on Anti- Derivatives	
40		Problems on Contour Integrals	
41		Problems on Upper bounds	
42		Problems on ML-Inequality	
43		Problems on Upper bounds for Modulli of Contour Integrals	
44		Exercise problems	
45		Exercise problems	
46	UNIT-IV	Cauchy Goursat theorem : Let f(z) be analytic in a Domain ‘D’ and f^1 is	

		continuous in 'D' then $\int f(z)dz = 0$ for every simple closed contour in D.	
47		Problems on Cauchy Goursat theorem	
48		Simply connected domain, Extension of Cauchy's Goursat theorem for closed contour: If the function 'f' is analytic throughout a simply connected domain 'D' then $\int_c f(z)dz = 0$ for every closed contour 'C' lying in 'D'.	
49		Multiple connected domain with examples	
50	Cauchy Integral Formula	Statement: Let 'f' be a analytic function everywhere inside on a simple closed contour 'C' taken in the positive direction if z_0 is any point interior to 'C' then f(z_0)=$\frac{1}{2\P i}\oint_c \frac{f(z)}{z-z_0}$dz	
51		Problems on Cauchy Integral Formula	
52		Problems on Cauchy Integral Formula	
53		Theorem on Cauchy Integral formula for Derivatives	
54		Problems on on Cauchy Integral formula for Derivatives	
55		Theorems : statement and proof of Morera's theorem and cauchy's inequality	
56		Louville's Theorem: If a function 'f' entire and bounded in the complex plane then f (z) is constant throughout in that complex plane.	
57		Fundamental Theorem of Algebra: Every n^{th} degree polynomial has at least on zero	
58		Statement and proof of Gauss Mean Value Theorem, theorem on Cauchy Integral formula for higher Order	
59		Theorem on Maximum Modulus Principle	
60		Exercise problems	

Subject: Elementary Operator Theory, **Paper: II (MM 302)**
Text Book: Introductory Functional Analysis by E.Kreyszig

Lecture No	Learning Objectives	Topics to be covered	
1	**Unit I** Spectral theory in finite dimensional normed spaces	Definitions of Eigen value, Eigen vector, Eigen space, Spectrum, Resolvent set, Theorem on eigen values of a matrix and exampals	
2		Theorem on All the matrices relative to various bases for X have the same eigen values	
3		Similar matrices,If T is self adjoint then its spectrum is real, T is unitary then its eigen values have absolute value 1	
4	Basic concepts of Spectral theory	Resolvent operator, Regular value, Resolvent set, Spectrum and different types of spectrum(Point, continuous and residual spectrum)	
5		Exampale for spectral value but not an eigen value	
6		Theorem on Domain of R_λ	
7	Spectral properties of bounded linear operators	Inverse Theorem	
8		Theorem on resolvent set is open and spectrum is closed	
9		Representation theorem on resolvent	
10		The spectrum is compact and lies in the disc $\|\lambda\| \leq \|T\|$, Spectral radius	
11	Further properties of Resolvent and Spectrum	Theorem on Resolvent equation, Commutativity,	
12		Theorem on $P(\lambda)$ is an eigen value of a polynomial matrix $P(A)$	
13		Spectral mapping Theorem	
14		Spectral mapping Theorem, Theorem on Linear independance	
15		Revision on Unit-I	
16	**Unit II** Compact linear operators in Normed spaces	Compact linear operator, Compact linear operator is bounded, Continuous and if $\dim(X) = \infty$ then Identity operator is not ompact	
17		Theorem on compactness criterian, Theorem on If T is bounded and $\dim(X) = \infty$ then T is compact and $\dim(X) < \infty$ then T is compact	
18			

		Theorem on sequence of compact linear operators	
19		Theorem on weak convergence, Problems	
20	Further properties of Compact linear operators	$\in -net$, Totally bounded, Lemma on total boundedness	
21		Theorem on separability of range, Theorem on compact extension	
22		Theorem on if T is compact then its adjoint operator is compact	
23	Spectral properties of Compact linear operators	The set of eigen values of compact linear operator is countable	
24		Theorem on compact linear operator	
25		If T is compact and S is bounded Then ST, TS are compact,	
26		If T is compact then $N(T_{\lambda})$ is finite dimensional. Corollary on Null space	
27		If T is compact then Range of $T(T_{\lambda})$ is closed. Corollary on Range	
27	Operator equations	Definition of operatoe equation, Necessary and sufficient condition for solvability of $Tx - \lambda x = y$	
28		Bound for certain solutions of $Tx - \lambda x = y$	
29		If T is compact solvability of functional $T^{\times} f - \lambda f = g$	
30		Revision on Unit II	
31	Unit III Spectral properties of bdd self adjoint operators	Hilbert adjoint operator, Self-adjoint operator,Theorem on eigen values and eigen vectors	
32		Theorem on resolvent set $\|T_{\lambda} x\| \geq C\|x\|$	
33		Theorem on m,M are the spectral values of T	
34		Theorem on $\|T\| = Sup\|, Tx, x >\|$	
35	Further Spectral properties of bdd self adjoint operators	Thyeorem on $\sigma(T)$ lies in [m,M]	
36		Theorem on $\sigma(T)$ is real	
37		Residual spectrum is empty	
38	Positive Operators	Positive operator, partial order, examples	
39		The product of two commutative positive operators is positive	
40		Problems on positive operators	
41		Theorem on monotonic sequence of operators	
42		Theorem on monotonic sequence of operators	
43	Square roots of positive operators	Positive square root, Theorem on Positive square root	

44		Theorem on Positive square root	
45		Revision of Unit III	
46	Unit IV Projection operators	Projection operator, Theorem on projection operator if and only if self-adjoint and idempotent	
47		Theorem on positivity, norm, problems	
48		Theorem on product of projections	
49		Theorem onsum of projections	
50	Further properties of projections	Theorem on partial order in projections	
51		Theorem on difference of projections	
52		Theorem on monotone increasing sequence of operators	
53		Theorem on monotone increasing sequence of operators	
54	Spectral family	Relation between self adjoint and projection operators, Spectral family	
55		Spectral representation of bdd self adjoint operator in terms spectral family	
56	Spectral family of bdd self adjoint operator	Positive and negative part T_λ ,Lemma on operators related to T and T_λ	
57		Theorem on spectral family associated with an operator	
58		Theorem on spectral family associated with an operator	
59		Revision of Unit IV	
60		Pre final exam	

Subject: Operations Research, **Paper: II (MM 303)**
Text Book: Operation Research by S.D.Sharma

Lecture No	Learning Objectives	Topics to be covered	
1	Unit I Introduction of LPP	Definition of linear programming problem	
2		Formulation of linear programming problem for maximization and minimization	
3	Graphical method	Algorithm of graphical method	
4		examples of graphical method	
5		Finding optimum solution of maximization of LPP by graphical method	

6		Finding optimum solution of minimization of LPP by graphical method	
7		Some special cases of graphical method	
8	Simplex method	Some basic Definitions of solutions	
9		Rules to convert the LPP to standard LPP and examples	
10		Algorithm of Simplex method	
11		Finding the optimum solution of LPP by simplex method	
12		Exercise problems on simplex method	
13	Two- phase Artificial method	Two- phase Artificial method algorithm and Exercise problems	
14	Big- M method	Big- M method algorithm and Exercise problems	
15	Degeneracy in LPP	Some exceptional cases of LPP and Resolving of degeneracy in LPP	
16	**Unit II** Introduction	Introduction of Assignment Problem	
17		Mathematical formulation of Assignment problem and matrix form	
18	Hungarian method	Algorithm of Hungarian method	
19		Exercise problems on assignment problems by using Hungarian method	
20		Special cases of Assignment problems	
21	Travelling salesman problem	Introduction of travelling salesman problem and mathematical formulation of the travelling salesman problem	
22		Optimum solution of travelling salesman problem by Hungarian method	
23	Transportation problem	Introduction of travelling salesman problem	
24		Mathematical formulation of travelling salesman problem and formation as Assignment problem	
		Necessary condition for solution of T.P	
25		Introduction of methods to find the I.B.F.S	
26		North –west corner rule method and Row minima and column minima method	
27		Matrix minima method and Vogel’s approximation method	
28		Degeneracy in T.P and construction of Loop in T.P	
29		Algorithm of Modi method or U-V method to find the optimum solutions	
30		Exercise problems	
31	Unit III Dynamic Programming	Introduction of Dynamic programming problem	

	Problem		
32		Mathematical formulation of DPP	
33		Characteristics of DPP	
34		Bellman's Principle of optimality	
35		Definitions of State and Stage and examples	
36		Forward and Backward approaches of DPP	
37		Minimum path problem	
38		Case I : single additive constraint and additively separable return	
39		Algorithm and finding the states	
40		Exercise Problems on Case I	
41		Case II : single additive constraint and multiplicative separable return	
42		Exercise Problems on Case II	
43		Case III : single multiplicative constraint and additively separable return	
44		Exercise Problems on Case III	
45		Some special cases	
46	UNIT IV Network analysis	Introduction of networks	
47		Some definitions regarding Networking analysis	
48	Network diagram	Introduction of network diagram	
49		Rules for drawing network diagram	
50		Exercise Problems on network diagram	
51		Forward recursive approach of Network	
52		Forward recursive approach of Network	
53		Some definitions of floats in network	
54	CPM	Finding the critical activity	
55		Finding the critical path	
56	PERT	Some definitions regarding project analysis	
57		Finding estimated time	
58		Introduction of the variance of Project	
59		Exercise problems on Finding the variance of Project	
60		revision	

Subject: : Integral Equations Paper: IV(a) (MM 304 B)

Text Book: M.Krasnov, A. Kislev, G. Makarenko, Problems and Exercises in Integral Equations (1971).

[2]. S.Swarup, Integral Equations (2008)

Lecture No	Learning Objectives	Topics to be covered	Remark
1	UNIT-I Volterra's integral equations	Introduction, Basic concepts, Volterra's linear integral equation of Ist kind, Solution of VIE, Examples and problems.	
2		Integrodifferential equations, Relation between linear differential equations and Volterra integral equations.	
3		Formation of integral equations corresponding to the differential equations	
4		Problems on formation of integral equations corresponding to the differential equations.	
5		Resolvent kernel of VIE, finding Iterated kernels	
6		Finding resolvent kernels and solution of VIE by using resolvent kernels.	
7		Problems for finding resolvent kernels	
8		Determination of some resolventkernels another method, problems.	
9		Solution of integral equation by resolvent kernels, problems.	
10		Finding Resolvent kernel and solution of VIE by using Laplace transforms.	
11		The method of successive approximations.	
12		Problem for finding solution of VIE by the method of successive approximations	
13	Convolution type equations	Convolution of two functions, convolution theorem, Convolution type integral equations.	
14		Solution of Convolution type equations.	
15		Problems for finding Solution of Convolution type equations.	

16	UNIT-II Solution of integro differential equations with the aid of Laplace Transforms	Definition of integro differential equations, Method of solving integro differential equations.	
17		Problems for solving integro differential equations.	
18		Volterra Integral Equations with limits (x,+∞)	
19		Problems for finding Solutions of VIE with limits (x,+∞),	
20		Volterra Integral Equations of first kind, Examples.	
21		Solution of Volterra Integral Equations of first kind, Problems.	
22		Volterra Integral Equations of the first kindof the convolution type and problems.	
23	Euler's integral	The Gamma function the properties and results in Gamma function.	
24		Gauss Legendre multiplication theorem and problems.	
25		Beta function and their properties.	
26		Results on Beta function and relation between Beta and Gamma function.	
27		Abel's problems.	
28		Abel's integral equation and problems	
29		Generalization of Abel's problem and its solution.	
30		Volterra Integral Equationof the first kind of the convolution type, problems.	
31	UNIT- III Fredholm Integral Equations.	A linear Fredholm Integral Equations, Homogeneous and non-homogeneous and Fredholm Integral Equations of 2^{nd} kind.	
32		Solution of Fredholm Integral Equations and problems.	

33		Checking the given function are the solutions of indicated integral equations.	
34		The method of Fredholm Determinants.	
35		Fredholm minor, Fredholm Determinant and Resolvent kernel, examples and problems.	
36		Finding R(x,t;λ) by using recursion relations and problems.	
37	Iterated kernels	Constructing Resolvent kernels with the aid of Iterated kernels.	
38		Orthogonal kernels, properties and examples.	
39		Finding iterated kernels, Integral Equations with degenerated kernels.	
40		Hammerstein type integral equation.	
41		Characteristic numbers and Eigen functions and its properties and examples.	
42		Problems for finding Characteristic numbers and Eigen functions and solution of homogeneous FIE.	
43		Solution of homogeneous FIE with degenerated kernels and problems.	
44		Fredholm integral equations with difference of kernels, Extremal properties of characteristic numbers and Eigen functions.	
45		Non homogeneous Symmetric equations.	
46	UNIT - IV	Applications of integral equations.	
47		Longitudinal vibrations of a rod.	
48		Deformation of a rod.	
49		Deformation of periodic solutions.	

50	Green's function	Green's function for ordinary differential equations and theorem(If the BVP has only one trivial solution $y(x) \equiv 0$, then the operator L has one and only one Green's function $G(x, \xi)$.	
51		An important special case for construction of Green's function for second order ODE.	
52		Construction of Green's function, Example 1 and 2.	
53		Problems for construction of Green's function, example 3.	
54		Using Green's function in the solution of BVP and theorem.	
55		Solving the BVP by using Green's function, Example 1 and problem.	
56		Example 2 Reducing to an integral equation to the non-linear integral equation, Problems.	
57		Problems: Solving the BVP by using Green's function.	
58		Boundary value problem containing a parameter, reducing to an integral equation Examples: Reducing the BVP to an integral equation.	
59		Examples: Reducing the BVP to an integral equation and problems.	
60		Singular integral equations and solution of a singular integral equations.	

Subject: Numarical Techniques **Paper: V(b) (MM 305 B)**

Text Book: Numarical Methods foe Scientific and Engineering Computation by M.K.Jain, SRK Iyengar, P.K.Jain

Lecture No	Learning Objectives	Topics to be covered	
1	**Unit I**	Introduction ,Algebraic equation, Transcendental equation	
2		Bisection method	

3		Problems an Bisection method	
4		Secant method and Regula falsi method	
5		Problems on Secant method and Regula falsi method	
6		Newton Raphson method	
7		Problems on Newton Raphson method	
8		Newton Raphson method has a second order convergence	
9		Muller method	
10		Problems on Muller method	
11		Chebyshev method	
12		Problems on Chebyshev method	
13		Multipoint iteration method	
14		Problems on Multipoint iteration method	
15		Revision on Unit-I	
16	**Unit II**	System of linear algebraic equations Direct methods	
17		Crammers rule, Matrix inversion method	
18		Gauss elimination method	
19		Gauss elimination by partial pivoting, complete pivoting	
20		Gauss Jordan method	
21		Method of factrization	
22		Problems on Method of factrization	
23		Partition method	
24		Problems on Partition method	
25		Gauss Jacobi method(Method of simultaneous displacement)	
26		Matrix method	
27		Problems on above method	
27		Gauss-Seidal method (Method of successivedisplacement)	
28		Problems on above method	
29		problems	
30		Revision on Unit II	
31	Unit-III	Finite differences, forward, backward, central differences, shift, average and central difference operators	
32		Relation between the operators	
33		Netwons forward interpolation formula	
34		Netwons Backward interpolation formula	
35		Gauss forward interpolation formula	
36		Gauss Backwardd interpolation formula	
37		Stirlings formula	
38		Bessals formula	
39		Central difference interpolation formula	
40		Everetts formula	
41		Lagranges interpolation formula	
42		Newtons divided difference formula	
43		Piecewise quadratic Interpolation, Piecewise linear Interpolation, Piecewise cubic Interpolation	

44		Spline Interpolation, Linear splines,Quadratic splines and cubic splines	
45		Method of least equars	
46	Unit IV Numarical differentiation	Newtons forward, Netwon Backward and stirlings differentiatin formulas	
47		Problems on above methods	
48	Numarical Integration	Newton Cotes Quadratere formula	
49		Trapezoidal Rule	
50		Simpsons 1/3 Rule and Simpsons 3/8 Rule	
51		Trapezoidal Rule based on undetermined coefficients	
52		Simpsons 1/3 Rule based on undetermined coefficients	
53		Gauss Legendre Integration method one point, two-point and three-point formula	
54	Numarical solutions of ODE	Taylors series method, Picards method	
55		Eulers method, Eulers modified method	
56		Runge Kutta II order method	
57		Runge Kutta fourth method	
58		Milnes Predictor-Corrector method	
59		Adms-Bashforth- Moulton Predictor-Corrector method	
60		Pre final exam	

M.Sc. Mathematics Syllabus Lecture wise plan for the academic year 2017-2018
Course: M.Sc. Mathematics
Year& Semester: II Year II Semester
Subject: Advanced Complex Analysis, Paper: I (MM 401)
Text Book: Complex Variable & Application 8th Edition by Jams Ward Brown,

RuelV.ChurchillMcGrawhill International Edition

	Learning Objectives	Topics to be covered	
1	UNIT-I Convergence of Sequence and Series	Introduction, Theorems and problems of Convergence of Sequences	
2		Theorems and problems of Convergence of Series	
3	Taylor's theorem	Statement and Proof	
4		Problems on Taylor's theorem	
5		Problems on Taylor's theorem	
6		Problems on Taylor's theorem	
7	Laurent's theorem	Statement and Proof of Laurent's theorem	
8		Examples and problems on Maclaurent's series	
9		Problems on Laurent's theorem	
10		Definition and theorem on Absolute and Uniform Convergence of Power Series	
11		Integration and Differentiation of Power Series and Corollary.	
12		Theorems on Uniqueness of Series Representation	
13		Multiplication and Division of Power Series	
14		Divisions of power series and some Expansions	
15		Problems on Multiplication and Division of Power Series	
16	UNIT-2 Residues & Singularities	Introduction to Singularities and Types of Singularities1) Isolated Singularity 2)Non Isolated Singularity with examples	
17	Isolated Singularity	1) Removable Singularity 2) Pole 3) Essential Singularity with examples	

18	Residue	Residue of an analytic function at an Isolated Singularity	
19		Problems on the classification of the nature of singularities and find their residues	
20		Theorem and Corollary on Residues at Poles	
21		Problems on Poles	
22	Cauchy’s Residue Theorem	Statement and proof of theorem	
23		Problems on Cauchy’s Residue Theorem	
24		Problems on Cauchy’s Residue Theorem	
25	Zeroes of an Analytic function	Definition, theorem with examples	
26		Theorems and problems on Zeroes and Poles	
27		Problems on Zeroes and Poles	
28	Behavior of functions near Isolated Singular points	Theorem and Lemma with examples	
29		Behavior of functions at Infinity	
30		Problems on Behavior of functions at Infinity	
31	UNIT-III Improper Integrals	Evaluation of Definite Integrals Involving Sins & Cosines	
32		Problems on Definite Integrals	
33		Evaluation of Improper Integral involving rational functions	
34		Problems on Improper Integral involving rational functions	
34		Problems on Improper Integral	
35	Jordan’s Lemma	Statement and Proof	
36		Procedure and problems on Improper Integrals from Fourier Analysis	
37		Problems on finding the Principle Value of Improper Integral	
38	Indented Paths	Statement and proof with problems	
39	Argument Principle	Definition of Merimorphic Function and statement & proof of Argument Principle with problems	

40	Rouche's Theorem	Statement & Proof of Rouche's Theorem with problems	
41	UNIT-IV Linear transformations	Introduction, Definition and problems on Linear Transformations	
42		Problems on Images	
43		The Transformation and Mapping by W=1/z	
44		Linear Fractional Transformations	
45		Problems of Bilinear Transformations W=T(z)= az+b/cz+d, ad-bc≠0	
46		Problems on An Implicit form	
47		Problems on An Implicit form	
48		Fixed point and problems	
49		Problems on Invariant Point, Home work to students	
50		Discussion on Homework problems	
51		Problems on Linear Fractional Transformation	
52		Problems on the classifications of given transformations	
53		Mappings of the Upper Half Plane	
54		Problems on Upper Half Plane	
55		The Transformation W=SinZ mapping by z^2	
56		Problems on mappings	
57		Exercise problems	
58		Revision of Unit-I, Unit-II	
59		Revision of Unit-III, Unit-IV	
60		Exam conducted	

Subject: General Measure Theory, Paper: II(MM 402)
Text Book: Real Analysis(Chapters 11, 12)by H.L Royden, Peasron Education

Lecture No	Learning Objectives	Topics to be covered	Remark
1	UNIT-I Chapter 11 Measure spaces	Introduction, Algebra of Sets, Examples, $\sigma - algebra\ of\ sets$, measurable space, measure on $(X, \mathcal{B})$ and measure space ($(X, \mathcal{B}, \mu)$, proposition $1 \mu(A) \leq \mu(B) \forall A \subseteq B$.	
2		Examples and proofs of measurable and measure spaces.	
3		Proposition 2, Proposition 3. And countable sub additive property of measure μ	
4		Finite measure, $\sigma - finite\ measure,$ semi finite measure and complete measure and examples.	
5		Completion of $(X, \mathcal{B}, \mu)$ Proposition 4 ,	
6	2. Measurable functions	Proposition 5, definition of measurable function and theorem 6	
7		Proposition 7 and proposition 8	
8		Ordinate sets, lemma 9 and proposition 10.	
9	3. Integration	Introduction, definition and properties of integral of a nonnegative measurable function.	
10		Fatou's lemma theorem 11	
11		Monotone convergence theorem, theorem 12	
12		Proposition 13, corollary 14 and integrable function f.	
13		Proposition 15, Lebesgue (dominated) convergence theorem. Theorem16	
14	4. General convergence theorems	Definition of$\mu_n \to \mu\ set\ wise$,Proposition 17, GernelizedFatous lemma.	
15		Gernelized monotone convergence theorem, Proposition 18, GernelizedLebesgue's dominated convergence theorem.	
16	UNIT-II 5.Signed Measures	Introduction, definition of signed measure, Positive set, Negative set, Null set and examples.	
17		Lemma 19	

18		Lemma 20	
19		Proposition 21, Hahn's decomposition theorem	
20		Singular measures, mutually singular measures, and examples.	
21		Proposition 22 Jordan's decomposition theorem. And uniqueness.	
22		Positive part, negative part and absolute value or total variation of signed measure ϑ.and ts properties.	
23		Suppose $(X, \mathcal{B}, \mu)$is a measure space. Let f be a measurable and integrable function on If $\vartheta(E) = \int_E \ f d\mu$. then ϑ is a signed measure and finding Hahn's and Jordan's decompositions.	
24	6. Radon-Nikodym theorem	Mutually singular measures, $\mu$is absolutely continuous w.r.to $\vartheta\vartheta << \mu$ and examples, The Radon –Nikodym theorem, theorem 23	
25		Proof of theorem 23 (The Radon –Nikodym theorem)	
26		The Radon Nikodym Derivative examples and applications of R-N theorem	
27		Proposition 24 Lebesgues decomposition theorem.	
28		Suppose $\vartheta_1$and ϑ_2 are two finite measures then $\alpha\vartheta_1 + \beta\vartheta_2$ is a signed measure$\forall \alpha, \beta \in \mathbb{R}$.and other properties.	
29		If ϑ is signed measure such that $\vartheta \perp \mu \ and \ \vartheta << \mu$ then $\vartheta = 0$,	
30		If E is any measureable set then$\vartheta^-(E) \leq \vartheta(E) \leq \vartheta^+(E)$ and $\lvert\vartheta(E)\rvert \leq \lvert\vartheta\rvert(E)$ and Complex Measures.	
31	UNIT-III Chapter-12 Measure and Outer measure	Introduction, Outer measure and measurability. Theorem 1, the class of measurable sets is a$\sigma - algebra\ of\ sets$.	
32		$\bar{\mu}$is the restriction of $\mu^* \ on\ \mathcal{B}$ is a complete measure.	
33		Let $\{E_i\} is\ a\ sequence\ of\ disjoint\ measurable\ sets\ and\ and\ E = \cup E_i then\ for\ any\ set\ A\ we\ have\ \mu^*(\mathrm{A} \cap E) = \sum \mu^*(\mathrm{A} \cap E_i)$	
34	2. The Extension theorem	Measure on an algebra $\mathcal{A}$., Outer measure induced by a measure μ	
35		Lemma 2 and Corollary 3	

36		Lemma 4, The set function $\mu^*$is an outer measure.	
37		Lemma 5, if $A\epsilon\mathcal{A}$ then A is measurable with respect to μ^*.	
38		Proposition 6, regular outer measure, Caratheodary outer measure.	
39		Proposition 7 and its proof and applications.	
40		Theorem 8, Caratheodary extension theorem.	
41		Semi algebra, algebra generated by a semi algebra and proposition 9.	
42	4. Product Measures	Measurable rectangle, Lemma 14, Product measure $\mu x\vartheta$. x cross section E_x.	
43		Lemma 15 E_x is measurable subset of Y for $E \in \mathcal{R}_{\sigma\delta}. and$ Lemma 16.	
44		Lemma 17 and Proposition 18.	
45		Theorem 19 Fubini's theorem and theorem 20, Tonelli's theorem	
46	UNIT IV 6. Inner Measure	Introduction, definition of inner measure and examples	
47		Lemma 27, $\mu_*(E) \le \mu^*(E), if\ E\epsilon\ \mathcal{R}\ then$ $\mu_*(E) = \mu(E)$. Lemma 28.	
48		Lemma 29, corollary 30($if\ A\epsilon\ \mathcal{R}\ then$ $\mu(A) = \mu_*(A \cap E) + \mu^*(A \cap \tilde{E})$).	
49		Lemma 31 $B\ is\ \mu^*\ measurable\ with\ \mu^*(B) < \infty$ then $\mu_*(B) = \mu^*(B)$.	
50		Proposition 32, Let E be a set with $\mu_*(E) < \infty$, then there is a set $H \in \mathcal{R}_{\delta\sigma} \ni H \subseteq E\ and\ \bar{\mu}(H) = \mu_*(E)$.	
51		Corollary 33 and proposition 34.	
52		Theorem 35,($E \cap F = \emptyset\ \ then$ $\mu_*(E) + \mu_*(F) \le \mu_*(E \cup F) \le \mu_*(E) + \mu^*(F) \le$ $\mu^*(E \cup F) \le \mu^*(E) + \mu^*(F)$.	
53		Corollary 36 Let $\{E_i\} is\ a\ sequence\ of\ disjoint\ sets$ $then\ we\ have\ \sum \mu^*(\mathrm{A} \cap E_i) \le \mu^*(\cup E_i)$	
54		Lemma 37, $\{A_i\} is\ a\ sequence\ of\ disjoint\ \ sets\ and\ for$ any set E we have $\mu_*(\mathrm{E}\cap (\cup A_i)) = \sum \mu_*(\mathrm{E} \cap A_i)$.	
55		Theorem 38 and its proof.	
56	7.Extension sets by measure zero	Introduction, proposition 39.	

57	8. Carathodary outer maesure	Two sets separated by the function $\varphi \in \Gamma$, examples, Carathodary outer measure w.r.to Γ	
58		Proposition 40, If μ^* is Caratheodary outer measure w.r.to Γ then every function of Γ is μ^* $measurable$	
59		Proposition 41.	
60		Hausdorff measures.	

Subject: Banach Algebra, Paper: III(B) (MM 403B)
Text Book: Lectures in Functional Analysis and Operator Theory by S.K.Berberian

Lecture No	Learning Objectives	Topics to be covered	
1	**Unit I** Deinition of Banach Algebra and examples	Introduction, Definitions of Algebra, Normed Algebra, Banach Algebra, *-Algebra	
2		Theorem The multiplication is jointly continuous, The product ot of two Cauchy sequences is Cauchy sequency	
3		Theorem on completion of Banach algebra	
4		Unitification of A, Theorem on Adjuction of unity	
5	Invertibility of a Banach algebra with unity	Definitions of invertible element and Inverse theorem	
6		Corollaries on on Inverse theorem	
7		Corollary: The set of all invertible elements U is an open sub set of A, singular element, Theorem on Bicontinuous	
8		Theorem on the mapping $x \to x^{-1}$ is differentiable,	
9	Resolvent and Spectrum	Definitions on Resolvent set of x, Spectrum of x, $\rho(x)$ is an open set, Resolventfunction of x	
10		Resolvent identity, Theorem on $LtR(\lambda) = 0$, R is differentiable	
11		Theorem on $Ltf(R(\lambda)) = 0$, f(R) is differentiable, $\rho(x)$ is a proper subset of C	
12		Gelfand-Mazur theorem, Spectrum of x is a Compact,Spectral radius of x	
13	Gelfand formula	Gelfand formula for Spectral radius	
14		Corollary on Gelfand formula	
15		Revision of Unit I	
16	**Unit II** Gelfand representation	Gelfand Algebra, closure of a proper ideal is proper ideal, Maximal ideal is closed	

	theorem		
17		$\frac{A}{I}$ is a Gelfand algebra,	
18		Gelfand Topology, Gelfand transform of x, x^{τ} is continuous	
19		Gelfand representation theorem	
20	The Rational functional calculus	$\phi : C[t] \to A$, range of ϕ is smallest sub algebra of A,	
21		Spectral mapping theorem for polynomial functions, Non singular	
22		$\Phi : C(t, \sigma(x)) \to A$ Range of Φ is the smallest sub algebra of A,full sub algebra	
23		Spectral mapping theorem for rational functions,	
24	Topological divisors of zero, Boundary	TDZ, Every TDZ is singular, boundary of S is twi sided TDZ in A	
		$\lambda.1 - x$ is two sided tdz in A, $\partial(\sigma_A(x)) \subset \partial(\sigma_B(x))$,If B is a closed *-sub algebra of A then B is full sub algebra of A	
25	Spectrum in L(E)	$T \in L(E)$ T is left divisor of zeroiff T is not injective,eigen value, point spectrum, Compression spectrum, bounded below	
26		Equivalient conditions:T is lTDZ, $Tx_n \to 0$, T is not bounded below. Approximate point spectrum	
27		Equivalent conditions on T is RTDZ, T^1 is LTDZ, Residual spectrum, continuous spectrum	
28		Equivalent conditions on T is surjective, T^1 is bounded below,Equivalent conditions on T is not injective, T is RTDZ, T^1 is not bounded below	
29		Equivalent conditions on T,T*, bounded below, T is self adjoint then $\sigma(T)$ is real	
30		Theorem on $m \in \sigma(T), M \in \sigma(T)$ Equivalient conditions: $(\frac{Tx}{x}) \geq 0$, $T^* = T$, $\sigma(T) \subset [0, \infty)$	
31	Unit III Definitions ans examples of C*- Algebras	Definition of C*-algebra, involution is isometric, if x*x=xx* then $r_A(x) = \|x\|$	
32		If x is self adjoint then $\sigma_A(x) \subset R$, $\sigma_B(x) = \sigma_A(x)$	
33		Theorem on A is a C*- algebra without unity may be embedded in a C*- algebra with unity.	
34	Commutative Gelfand algebra	Commutative Gelfand Naimark theorem	

35	*-Representation	*-homomorphisim, Theorem on $\|\phi(a)\| \leq \|a\|$, *-representation	
36		Theorem on $\phi: A \to L(H)$ then $\|\phi(a)\| = Sup\|\phi_i(a)\|$	
37	States on a C*- Algebra	Def. State and normalized, Positive theorem on $a \geq 0$ Relative to B iff $a \geq 0$ relative to A	
38		Theorem on if $b \geq 0$ and b^2=a, sum of positive elements is positive, If $-a \geq 0$ then a=0	
39		Equivalent conditions f is state, f is continuous	
40		Theorem on $f(a^*a) = \|a^*a\|$ theorem on if f is a state on A then $f(a) = (\phi(a)u/u)$	
41		Numarical status, Theorem on self adjoint elementa of A	
42		Definitions on cone, pointed cone,sailent and thin	
43		Theorem on $\sum(a)$ is non-empty, compact and convex subset of C	
44		Theorem on if a is self adjoint then $\sum(a) = convex\ of\ \sigma(a)$	
45		Revision of Unit III	
46	UNIT IV Gelfand Theorem	Gelfand- Naimark theorem representation theorem	
47	The continuous functional calculus	Theorem on $\phi: C(\sigma(a) \to A$ is homomorphisim, isometry	
48		Spectral mapping theorem on c*-algebra, If a is normal then $(f0g)(a) = f(g(a))$	
49	Spectral sets	Definition of spectral set, Equivalent conditions σ is a spectral set, $\|f(T)\| \leq 1$	
50		Super set of a spectral set is a spectral set, σ is spectral set iff its closure is a spectral set	
51		Equivalent conditions $\sigma(T)$ is a spectral set for T, $\|f(T)\| = r(f(T))$	
52		Spectrum of a normal operator is a spectral set, Equivalent conditions T is unitary, The unit circle π is a spectral set for T	
53		$f(\tau)$ is a spectral set for $f(T)$, Equivalent conditions T* = T , R is a spectral set for T	
54		Definition of σ-analytic, thin, theorem on	

		if T is thin spectral set then T is normal	
55		Lemma on $\|f(T)\| \leq \|f\|$	
56		Theorem on if $\|T\| \leq 1$, then $\|f_n(T) - f(T)\| \to 0$	
57		Theorem on if $\|T\| \leq 1$ iff Δ_1 is a spectral set for T	
58		Corollary on above theorem	
59		Revision of Unit IV	
60		Pre final exam	

Subject: Finite Difference Methods, Paper: IV(A)(MM 404A)

Text Book: : Computational Methods for Partial Differential Equations, Wiley Eastern Limited, New Age International Limited, New Delhi-M.K.Jain, S.R.K.Jain

	Learning Objectives	Topics to be covered	
1	UNIT-I Finite Difference Methods	Introduction, Definitions of Finite Difference Methods, Classification of Second Order Partial Differential Equations with conditions	
2		Hyperbolic equations, Parabolic Equations, Elliptic Equations, with examples	
3		Problems on Classification of Partial Differential Equations with standard form(or) Canonical Form	
4		Types of initial and boundary value problem: I-Pure initial value problem:- (Cauchy Problem), Initial Boundary value problem, Dirichlet boundary value problem, Neumann Boundary value problem and Mixed Boundary Value Problem with examples	
5	Difference Methods	One dimensional case, two dimensional case with examples, Finite Difference Approximations to Derivatives	
6		Continuation of Finite Difference Approximations to Derivatives	
7		Definition of Truncation Error and simplification of procedure.	
8		LAX Equivalence Theorem	
9		Routh-Hurwitz Criterion	
10		Theorem on Hurwitz	
11		Simplification of Forward Difference Approximation , Backward Difference Approximation and Central Difference Approximation of 2^{nd} order	

12		Problems on standard form(or) Canonical Form	
13		Simplification of Forward, Backward and Central Difference Approximation.	
14		Problems on standard form(or) Canonical Form	
15		Exercise Problems	
16	UNIT-II Difference Methods for Parabolic Partial Differential Equations	Definition and One Space Dimension(Heat equation), Schmidtz Method and Truncation Error, Laasonen Method and Truncation Error	
17		Laasonen Method and Truncation Error	
18	Crank-Nickolson Scheme	Procedure and another form of Crank-Nickolson Scheme	
19		Truncation error in Crank-Nickolson Method	
20		A general Two Level Difference Method, Three level difference methods with Dufort-frankel Method.	
21		Problems on Heat Condensial Equation by i) Schmidtz Method ii) Laasonen Method	
22		Problems on Heat Condensial Equation by iii) Crank-Nickolson Method, iv) Dufort- Frankel Method	
23		Problems on Heat Condensial Equation by iii) Crank-Nickolson Method, iv) Dufort- Frankel Method	
24		Stability and Convergent Analysis, Von-Neumann Method, The Stability analysis by Schmidtz Method, Stability of Laasonen Method	
25		Matrix Stability Analysis for Schmidtz Method, Stability Analysis for the Crank-Nickelson Method, The Stability analysis for Richardson Method, Stability analysis of Dufort-Frankel Method.	
26	Two Space Dimension	Procedure and problems on Two Dimensions Heat Equation using Explicit Method	
27	Alternate Direction Implicit Method (ADI)	The Peaceman Rachford ADI Method , D'yaknov Split Method , Douglas Rachford ADI Method	
28		Find the solution of two dimensional heat conduction equation using Peaceman Rachford ADI Method.	
29		Variable coefficient problems , Spherical and Cylindrical coordinate systems,	

30		Derivative boundary conditions and problems, Non-Linear Equations, second order methods to solve Non-linear Equations problems using Crank-Nickolson Method	
31	**Unit III Hyperbolic equations**	Introduction of hyperbolic equation of first, second orders	
32		Introduction of Finite differences	
33		Introduction of Finite difference approaches to hyperbolic equation.	
34		Explicit scheme for first order hyperbolic equation.	
35		Truncation error and stability analysis of first order hyperbolic equation.	
36		implicit scheme for first order hyperbolic equation.	
37		Truncation error and stability analysis of first order hyperbolic equation.	
38		Finite difference methods for first order hyperbolic equation.	
39		Introduction of hyperbolic equation of second orders and Finite difference approaches	
40		Explicit scheme for first second hyperbolic equation.	
41		Truncation error and stability analysis of second order hyperbolic equation.	
42		implicit scheme for second order hyperbolic equation.	
43		Truncation error and stability analysis of second order hyperbolic equation.	
44		Finite difference methods for second order hyperbolic equation.	
45		Exercise problems on hyperbolic equation.	
46	**UNIT IV Elliptic equation**	Introduction of elliptic equation of first, second orders	
47		Introduction of Dirichlet problem laplacian	
48		Derivative the dirichlet problem of laplace	
49		Exercise problems on dirichlet problem	
50		Introduction of Dirichlet problem poissions equations	
51		Derivative the dirichlet problem of poissions equations	
52		Exercise problems on dirichlet problem poissions equations	

53		Neumann problems	
54		Mixed problems	
55		General second order linear equations and problems	
56		Quasi linear elliptic equations	
57		Elliptic equations in polar coordinats	
58		Finite difference approaches for	
59		Finite difference methods for elliptic equations	
60		Exercise problems of elliptic equation.	

Subject: Calculas of variations, Paper: V(A)(MM 405A)
Text Book: Differential Equations and Calculus of variations by L.Elsgolts

Lecture No	Learning Objectives	Topics to be covered	
1	**Unit I** Introduction of Functional	Definition of functional and examples	
2		Properties of Functional	
3		Line arc functional	
4		Applications of functional	
5	Strong and weak variations	Definition of strong variation with examples	
6		Definition of weak variation with examples	
7	Derivation of Euler's equation	Necessary condition for the functional to be extremism.	
8		Corollary of Euler's equation	
9		Other forms of Euler's equation	
10	Special cases	Derivation of Euler's equation for the functional independent of x and examples	
11		Derivation of Euler's equation for the functional independent of y and examples	
12		Derivation of Euler's equation for the functional independent of y' and examples	
13		Derivation of Euler's equation for the functional independent of y and y' and examples	
14	Fundamental lemma of	State and prove fundamental theorem of	

	CoV	CoV	
15		Applications of CoV	
16	**Unit II** Problems of CoV	Minimum surface problem introduction	
17		Minimum surface revolution definition and applications	
18		Minimum surface revolution theorem and proof	
19	**Energy Problems**	Minimum energy problem introduction	
20		Minimum energy problem and solution	
21		Applications of Minimum energy problem	
22	**Brachistochrone Problem**	Brachistochrone Problem introduction	
23		Brachistochrone Problem with solution	
24		Applications	
	Variational Notations	Introduction of Variational notations	
25		Variational form of Functional	
26		Derivation of Euler's equation of variational problem	
27		Special cases of Euler's Equation.	
28	**Variational problem involving several functions**	Definition of functional involving several functions	
29		Derivation of Euler's equation of variational problem involving several functions	
30		Problem solving of variational problem involving several functions	
31	**Unit III** **Isoperimetric Problems**	Introduction of Isoperimetric Problem	
32		State and prove Isoperimetric problem	
33		Examples on Isoperimetric Problems	
34	**Variational Problems in Parametric form**	Introduction of Variational Problems in Parametric form **.**	
35		Derivation of Euler's equation in Two dependent variables Variational Problems in Parametric form **.**	
36		Problems on Two dependent variables Variational Problems in Parametric form **.**	
37	**Functional dependent on higher order derivatives**	Introduction and formulation of Functional dependent on higher order derivatives.	
38		Derivation of Euler's equation of Functional dependent on higher order derivatives.	
39		Problems of Functional dependent on higher order derivatives.	
40	**Euler's Poisson Equation**	Introduction of Euler's poisson equation	
41		Derivation of Euler's poisson equation	
42		Applications of Euler's poisson equation	
43		Examples of Euler's poisson equation	
44		Derivation of Laplace equation	
45		Examples of Laplace equation.	
46	**UNIT IV**	Discussion on Applications of CoV	

	Applications of CoV		
47	**Hamilton Principle**	Introduction of Hamilton's Principle	
48		Derivation of Hamilton's principle	
49		Special cases of Hamilton's principles	
50	**Lagrange's Equation**	Introduction of Lagrange's equation	
		Derivation of Lagrange's equation	
51		Applications of Lagrange's Equation	
52	**Hamilton's Equation**	Introduction of Hamilton's equation	
53		Derivation of Hamilton's equation by using Lagrange's equation.	
54	**Variational problems with movable boundaries**	Introduction of boundary conditions	
55		Discussion of derivative boundary conditions	
56		Von- Numannboundary conditions.	
57		Introduction of movable boundaries	
58		Functional form of movable boundaries	
59		Problems on movable boundaries	
60		Revision	