SCHOOL OF ARCHITECTURE, SCIENCE AND TECHNOLOGY
YASHWANTRAO CHAVAN MAHARASHTRA OPEN UNIVERSITY

Syllabus: V57:M.Sc. (Mathematics) {2015 Pattern}

2015

AST, YCMOU, NASHIK-422 222, MS, INDIA

CONTENTS

BASIC INFORMATION

1. **Mode of Education**: Blended or Hybrid Mode.
2. **Minimum Programme Duration**: 2 years/ 4 semesters after B.Sc./B.A. with Maths or Equivalent pass with Maths
3. **Total Courses and Credit Points:** 5 Theory courses each of 4 credit point at each semester. Total 20 courses of total 80 credit points at Semesters 01-04.
4. **Required Study Efforts**: Total 2400 Hours (including Self-Study) during all 4 semesters. 600 Hours (including Self-Study) during **each** semester.
5. **Medium of Instruction**: English
6. **Profile of Prospective Students**: In-Service Science Teachers from Schools/ Junior College and Equivalent pass students
7. **Attendance**: Minimum **75 %** attendance recommended for all Theory type of courses.
8. **Equivalence Status**: UGC recognized and approved

ELIGIBILITY AND FEES

Admission Eligibility	**Certification Eligibility**	**Fees and Deposit / Semester** UF + SCF is payable to university along with admission form. SCF is payable to respective study center during first week after the start of each semester.		
BSc/ BA with Maths/ BE/ BTech or equivalent pass	Min 40% or better marks in total 20 courses (subjects) of total 80 credit points at Semesters 01-04. Aggregate performance and Class in the programme shall be reported on the basis of **only** semesters 03-04.	**Desc**	**INR ₹**	**USD $**
		University Fee (UF)	**3,000**	300
		Study Center Fee (SCF)	**3,000**	300
		Additional Services Fee (ASF)	NA	NA
		UEF (University Exam Fee) for each exam form for repeater students)	500	50
		Total ≈	**6,000**	**600**
		Refundable LD (Payable only when student choose to avail Library Facility at the SC)	**1,500**	**150**

PROGRAMME STRUCTURE

V57: M.Sc.(Mathematics){2015 Pattern}					
Course → Sem ↓	Course 01, 4 CR, T	Course 02, 4 CR, T	Course 03, 4 CR, T	Course 04, 4 CR, T	Course 05, 4 CR, T
Sem 01 20 CR	**S24011**: Algebra -I	**S24012**: Advanced Calculus	**S24013**: Real Analysis	**S24014**: Differential Equations	**S24015**: Classical Mechanics
Sem 02 20 CR	**S24021**: Linear Algebra	**S24022**: General Topology	**S24023**: Complex Analysis	**S24024**: Numerical Analysis	**S24025**: Differential Geometry
Sem 03 20 CR	**S24031**: Functional Analysis	**S24032**: Advanced Discrete Mathematics	**S24033**: Number Theory	**S24034**: Integral Equations	**S24035**: Operation Research -I
Sem 04 20 CR	**S24041**: Measure and Integration	**S24042**: Partial Differential Equations	**S24043**: Riemannian Geometry - I	**S24044**: Riemannian Geometry - II	**S24045**: Operation Research -II
Development Scheme:			Teaching-Learning Scheme:		

• Minimum 24 Lectures for each course (01 – 05) @ 2 Lectures / Week shall be developed	• Minimum **24** Lectures for each course (01 – 05) @ 2 Lectures / Week, during each semester. • Minimum 8 Counselling Sessions each of 1 hr for each Theory Course shall be provided by the counsellors at the Study Center during each semester

SEMESTERS AND COURSES

SN	Code	Name	CA	EE	TM	Type	CR	Grade Point
Semester 01: 20 CRs, Specializations of M.Sc.								
01	S24011	Algebra - I	20	80	100	T	4	4
02	S24012	Advanced Calculus	20	80	100	T	4	4
03	S24013	Real Analysis	20	80	100	T	4	4
04	S24014	Differential Equations	20	80	100	T	4	4
05	S24015	Classical Mechanics	20	80	100	T	4	4
Semester 02: 20 CRs, Specializations of M.Sc.								
06	S24021	Linear Algebra	20	80	100	T	4	4
07	S24022	General Topology	20	80	100	T	4	4
08	S24023	Complex Analysis	20	80	100	T	4	4
09	S24024	Numerical Analysis	20	80	100	T	4	4
10	S24025	Differential Geometry	20	80	100	T	4	4
Semester 03: 20 CRs, Specializations of M.Sc.								
11	S24031	Functional Analysis	20	80	100	T	4	4
12	S24032	Advanced Discrete Mathematics	20	80	100	T	4	4
13	S24033	Number Theory-	20	80	100	T	4	4
14	S24034	Integral Equations	20	80	100	T	4	4
15	S24035	Operation Research –I	20	80	100	T	4	4
Semester 04: 20 CRs, Specializations of M.Sc.								
16	S24041	Measure and Integration	20	80	100	T	4	4
17	S24042	Partial Differential Equations	20	80	100	T	4	4
18	S24043	Riemannian Geometry -I	20	80	100	T	4	4
19	S24044	Riemannian Geometry – II	20	80	100	T	4	4
20	S24045	Operation Research –II	20	80	100	T	4	4

GRADING SYSTEM

1. "**Absolute Grading**": the marks are converted to grades based on pre-determined class intervals.
2. "**Letter Grade**": It is an index of the performance of students in a said programme. Grades are denoted by letters O, A+, A, B+, B, C, P and F.
3. "**Grade Point**": It is a numerical weight allotted to each letter grade on a 10-point scale. Grade Point shall be "0 (Zero)" for Letter Grade "Ab" and "F". The marks scored by the examinee shall be converted into grade points by dividing the marks scored in the aggregate and dividing the resulting number by maximum marks, multiplying the result by ten, retaining the integer part (ignore the fractional part). Thus if a person has secured 56 marks out of 100 marks in aggregate for a course, we get (56/100) x 10 which is 5.6. Ignoring the fraction, we get 5 as the grade point.

Letter Grade	Grade Point	Class
O	10	Outstanding
A+	9	Excellent
A	8	Very Good
B+	7	Good
B	6	Above Average
C	5	Average
P	**4**	**Pass**
F	**0**	**Fail**
Ab	**0**	**Absent**

4. "**Credit Point**": It is the product of grade point and number of credits for a course.
5. "**Semester Grade Point Average (SGPA)**": It is a measure of performance of work done in a semester. It is ratio of total credit points secured by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed up to two decimal places.
6. "**Cumulative Grade Point Average (CGPA)**": It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.
7. "**Transcript or Grade Card or Certificate**": Based on the grades earned, a grade certificate shall be issued to all the registered students after every semester. The grade certificate will display the course details (code, title, number of credits, grade secured) along with SGPA of that semester and CGPA earned till that semester.

EVALUATION PATTERN

SN	Type of Course	Continuous Assessment	End Examination
1	Theory (T)	"Continuous Assessment (**CA**)" of total **20** marks and total 4 SAQs, each of 5 marks, 1 SAQ on **each** CR in a **Single attempt only**	"End Examination (**EE**)" of total **80** Marks and **16** "Short Answer Questions (SAQs)" **each** of **05** marks (**4 out of 5 SAQs on each Credit**), during **150** Minutes. (**80%**)

1. **Separate and independent passing @ 40% in EE and (CAT+EE) shall be essential for Theory and Practical component of each course.** "CA, EE and Total marks" shall be separately reported for each course in the transcript or mark-statement.
2. **Only 1 attempt** for EE for **each** course, shall be allowed in **each** semester. **Maximum 2 attempts**, for CAT for **each** course, shall be allowed in **each** semester.
3. **Only best of past performance shall be reported in transcript or mark statement**.
4. **Total student evaluation for**
    a. **Each** semester shall be for **500** marks.
    b. **Each** year shall be for **1000** marks
    c. **Each** regular PG degree shall be for **2000** marks.

SUCCESSFUL COMPLETION OF COURSE OR PROGRAMME

1. "Successful Completion of the Course" means - either course is exempted or student gets minimum specified or better grade, either in end examination of that course or by credit transfer. A student obtaining grade "F" shall be considered failed and will be required to reappear in the examination. The student obtained minimum "P" (Pass) letter grade required for successful completion of the each course.
2. "Successful Completion of the Programme" means – all courses at all semesters are successfully completed and the student obtained "P" (Pass) letter grade for all courses at all semesters along with minimum specified SGPA and CGPA.

SEMESTER 01

S24011: ALGEBRA-I

PROGRAMME INFORMATION

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: http://www.ycmou.ac.in/ and http://ycmou.digitaluniversity.ac/
2	School	School of Architecture, Science and Technology
3	Discipline	Science
4	Level	PG
5	Course Used in	V57: M.Sc.(Maths)

COURSE INFORMATION

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	S24011	Algebra – I	4	8	120	20	80	100	T

PRESUMED KNOWLEDGE AND LEARNING OBJECTIVES

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: • BSc/BA with Mathematics or equivalent from a recognized University/Board.	After successful completion of this course, student should be able to • •

UNITS

UN	Name of the Unit	CSs	Questions
01-01 01-02 01-03	**Isomorphism Theorems** **Solvable Groups** **Series of A Group**	**CR 01** **MLs** **01-20**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
02-01 02-02	**Sylow Theorems** **Ring of Polynomials**	**CR 02** **MLs** **21-40**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
03-01 03-02	**Theory of Modules** **Sum and Direct Sum of Submodules**	**CR 03** **MLs** **41-60**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
04-01	**Noetherian and Artinian Modules**	**CR 04** **MLs** **61-80**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR

DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	**Isomorphism Theorems :** Introduction, Basic Definitions and Results, Isomorphism Theorems, Solvable Groups	CR 01
1-2	**Solvable Groups :** Introduction, Derived subgroup of a group G, Isomorphism Theorems.	
1-3	**Series of A Group:** Introduction, Subnormal Series, Normal Series, Ascending Central Series, Nilpotent Groups.	
2-1	**Sylow Theorems :** Introduction, Group action on a set, Class equation of a group, p- groups, Three Sylow theorems.	CR 02
2-2	**Ring of Polynomials:** Introduction, Ring of polynomials R[x]: Definition and Examples, Basic properties of R[x]., Division Algorithm, Euclidean Domain and Unique Factorization Domain, Zero of the Polynomial, Irreducible Polynomials in R[x],Factorization in F[x] and Eisenstein Criterion**.**	
3-1	**Theory of Modules:** Introduction, Modules – Definition and examples, Submodules, Homomorphism, Fundamental theorem of homomorphism and its applications.	CR 03
3-2	**Sum and Direct Sum of Submodules:** Introduction, Sum of modules, Direct sum of modules, Free modules, Completely reducible modules.	
4-1	**Noetherian and Artinian Modules:** Introduction, Noetherian and Artinian Modules, Artinian Module	

LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination			
CW-S24011			
Text-Books			
S24011-T01	Algebra – I Dr. Y.S.Powar Dept. Of Mathematics	Third 2014	Shivaji University, Kolhapur

S24012: Advanced Calculus

Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: http://www.ycmou.ac.in/ and http://ycmou.digitaluniversity.ac/
2	School	School of Architecture, Science and Technology
3	Discipline	Science -
4	Level	PG
5	Course Used in	V57: M.Sc.

Course Information

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	S24012	Advanced Calculus	4	8	120	20	80	100	T

Presumed Knowledge and Learning Objectives

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: • BSc/BA with Mathematics as Principle subject or equivalent from a recognized University/Board.	After successful completion of this course, student should be able to • •

Units

UN	Name of the Unit	CSs	Questions
01-01 01-02 01-03	**Sequences of Functions** **Double Sequence** **Series of Function**	**CR 01** **MLs** **01-20**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
02-01 02-02	**Power Series and Its Properties** **Multivariable Differential Calculus**	**CR 02** **MLs** **21-40**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
03-01 03-02	**Implicit Function and Extremum Problems** **Path and Line Integrals**	**CR 03** **MLs** **41-60**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
04-01	**Surface Integrals**	**CR 04** **MLs** **61-80**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR

Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
1-1	**Sequences of Functions:** Introduction, Convergence of sequence of real numbers,Uniform Convergence, Uniform Convergence and Reimann Integration,	**CR 01**
1-2	**Double Sequence:** Introduction, Definition, uniform convergence and Double Sequence, Mean convergence.	

1-3	**Series of Function**: Introduction**,** Series of Function, Definition, Rearrangement of Series, Rearrangement Theorem for Double Series.	
2-1	**Power Series and Its Properties:** Power Series, Introduction, Real Power Series, Binomial Series.	**CR 02**
2-2	**Multivariable Differential Calculus:** Introduction, Directional Derivative, Definition, Total Derivative, The Mean Theorem for Differentiable Functions.	
3-1	**Implicit Function and Extremum Problems:** Introduction, Notation, Functions with non-zero Jacobian Determinant, Theorem.	**CR 03**
3-2	**Path and Line Integrals:** Introduction, Definition, Theorem, Multiple Integrals.	
4-1	**Surface Integrals:** Implicit representation, The Fundamental Vector Product, Stoke's Theorem, The Divergence Theorem (Gauss Theorem).	

LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination			
CW-S24012			
Text-Books			
S24012-T01	Advanced Calculus Dr. M.S. Bapat (Willingdon College Sangli) Dr. H.G. Datar (Willingdon College Sangli)	First 2013	Shivaji University, Kolhapur

S24013: Real Analysis

Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: http://www.ycmou.ac.in/ and http://ycmou.digitaluniversity.ac/
2	School	School of Architecture, Science and Technology
3	Discipline	Science
4	Level	PG
5	Course Used in	V57: M.Sc.(Maths)

Course Information

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	S24013	Real Analysis	4	8	120	20	80	100	T

Presumed Knowledge and Learning Objectives

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: • BSc/BA with Mathematics or equivalent from a recognized University/Board.	After successful completion of this course, student should be able to • •

Units

UN	Name of the Unit	CSs	Questions
01-01 01-02	**Open Sets, Closed Sets and Borel Sets** **Lebesgue Measure**	**CR 01** **MLs** **01-20**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
02-01 02-02	**Lebesgue Measureable Functions** **Lebesgue Integral**	**CR 02** **MLs** **21-40**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
03-01 03-02	**The General Lebesgue Integral** **Differentiability of Monotone Functions**	**CR 03** **MLs** **41-60**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
04-01 04-02	**Absolutely Continuous Functions** **The L^p Spaces**	**CR 04** **MLs** **61-80**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR

Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
1-1	**Open Sets, Closed Sets and Borel Sets:** introduction, Open Sets and Closed Sets, Definition, Heine Borel Theorem, The σ - algebra.	**CR 01**
1-2	**Lebesgue Measure:** introducation,Lebesgue Outer Measure, Lebesgue Measurable Sets,Outer and Inner Approximation of Lebesgue Measurable Sets, Lebesgue Measure,Nonmeasurable Sets.	

2-1	**Lebesgue Measureable Functions:** introduction, Measurable Functions, Sequential Pointwise Limits and Simple Approximation, Littlewood's Three Principles.	**CR 02**
2-2	**Lebesgue Integral:** introduction, Riemann Integral, Lebesgue Integral of a Bounded Measurable Functions, Lebesgue Integral of a Non-negative Measurable Functions.	
3-1	**The General Lebesgue Integral:** introduction, General Lebesgue Integral**,** Characterization of Riemann and Lebesgue Integrability.	**CR 03**
3-2	**Differentiability of Monotone Functions:** introduction, Vitali's Lemma, Functions of Bounded Variations.	
4-1	**Absolutely Continuous Functions:** introduction Absolutely Continuous Functions, Integrating Derivatives: Differentiating Indefinite Integrals.	
4-2	**The L^p Spaces:** introduction Normed Linear Spaces, The Inequalities, L^p is Complete: The Riesz-Fischer Theorem.	**CR 04**

LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination			
CW- S24013		2015	YCMOU
Text-Books			
S24013- T01	Real Analysis Dr.M.S.Bapat	Second 2014	Shivaji University, Kolhapur

S24014: Differential Equations

Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: http://www.ycmou.ac.in/ and http://ycmou.digitaluniversity.ac/
2	School	School of Architecture, Science and Technology
3	Discipline	Science
4	Level	PG
5	Course Used in	V57: M.Sc.(Maths)

Course Information

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	S24014	Differential Equations	4	8	120	20	80	100	T

Presumed Knowledge and Learning Objectives

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: • BSc/BA with Mathematics or equivalent from a recognized University/Board.	After successful completion of this course, student should be able to • •

Units

UN	Name of the Unit	CSs	Questions
01-01	**Linear Equations with Constant Coefficients**	CR 01 MLs 01-20	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
02-01	**Linear Equations with Variable Coefficients**	CR 02 MLs 21-40	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
03-01	**Linear Equations with Regular Singular Points**	CR 03 MLs 41-60	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
04-01 04-02	**Existence and Uniqueness of Solution to First Order Equations** **Green's Function and Sturm liouvill Theory**	CR 04 MLs 61-80	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR

DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	**Linear Equations with Constant Coefficients:** Initial value problems for second order equations, Linear dependence and independence, The homogenous equation of order n,The non- homogenous equation of order n.	CR 01
2-1	**Linear Equations with Variable Coefficients: Homogenous equations with variable coefficients:** Initial value problems for the homogenous equation, Solutions of homogenous equation, Reduction of an order of a homogenous equation, **Basis:** Linear independence and Wronskian, Solutions of non- homogenous equation. **Homogenous equation with analytic coefficients:** Homogenous equation with analytic coefficients.	CR 02
3-1	**Linear Equations with Regular Singular Points:** Introduction, Euler equation, Second order equations with regular singular points, The Bessel equation, Regular singular points at infinity.	CR 03
4-1	**Existence and Uniqueness of Solution to First Order Equations**: Introduction, The method of successive approximations, Convergence of the successive approximations.	CR 04
4-2	**Green's Function and Sturm liouvill Theory:** Introducation, Green's Funcations, Sturm-Liouville Theory	

LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination			
CW- S24014		2015	YCMOU
Text-Books			
S24014-T01	Differential Equations Dr.(Mrs.) Sarita Thakar (Dept. Of Mathematics) Dr.Kishor D. Kucche (Dept. Of Mathematics)	Third 2014	Shivaji University, Kolhapur

S24015: Classical Mechanics

Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: http://www.ycmou.ac.in/ and http://ycmou.digitaluniversity.ac/
2	School	School of Architecture, Science and Technology
3	Discipline	Science
4	Level	PG
5	Course Used in	V57: M.Sc.(Maths)

Course Information

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	S24015	Classical Mechanics	4	8	120	20	80	100	T

Presumed Knowledge and Learning Objectives

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: • BSc/BA with Mathematics or equivalent from a recognized University/Board.	After successful completion of this course, student should be able to • •

Units

UN	Name of the Unit	CSs	Questions
01-01	**Lagrange's Formulation**	CR 01 MLs 01-20	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
02-01	**Variational Principles**	CR 02 MLs 21-40	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
03-01	**Hamilton's Principles and Hamilton's Formulation**	CR 03 MLs 41-60	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
04-01	**The kinematics of a Rigid Body Motion**	CR 04 MLs 61-80	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR

DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	**Lagrange's Formulation:** Basic Concepts, Introduction, Equation of Motion and Conservation Theorems, Equation of Motion of a system of particles, Conservation Theorem of Linear momentum of the system of particles, Angular Momentum of the system of particles, Conservation Theorem of Angular Momentum of the system of particles, Some definitions, Holonomic and non-holonomic Constraints, Scleronomic and Rheonomic Constraints, Worked Examples, Degrees of freedom and Generalized co-ordinates, Transformation Relations, Virtual Work, Principle of Virtual Work, D' Alembert's Principle, Generalized Velocities, Virtual displacement, Generalized force , **Lagrange's Equations:** Introduction, Lagrange's Equations of motion from D' Alembert's Principle, Conservative system, Non-Conservative system, Partially Conservative and Partially Non-Conservative system, Conservative of Energy, Kinetic Energy a Homogeneous Quadratic Function of Generalized Velocities, Another way of proving conservation theorem for energy. **Lagrange's Equations for Non-holonomic Constraints :** Introduction, Theorem,Atwood's Machine, Spherical Pendulum, Compound Pendulum, **Generalized Momentum and Cyclic co-ordinates:** Introduction, Generalized Momentum, Cyclic or ignorable Co- ordinates, Conservation Theorem for generalized momentum, Conservation Theorem for Energy, Conservation Theorem for Linear momentum,	**CR 01**
2-1	**Variational Principles: Euler-Lagrange's Differential Equations:** Introduction, Basic Lemma, Theorem, Important Note, Generalization of Theorem, (1): Euler-Lagrange's equations for several dependent variables, The Brachistochrone Problem, When integrand is a function more than two dependent variables. **Isoperimetric Problems:** Introduction, Generalization of Theorem 4: Euler-Lagrange's equations for Several dependent variables.	**CR 02**
3-1	**Hamilton's Principles and Hamilton's Formulation :** Introduction, Hamilton's Principles (for non-conservative system), Action in Mechanics, Derivation of Lagrange's equations for motion from Hamilton's Principles. **Hamiltonian Formulation:** Introduction, The Hamiltonian function, Hamilton's Canonical Equation of Motion, Derivation of Hamilton's Equations of motion from Hamilton's Principle, Lagrangian from Hamiltonian and conversely, Physical Meaning of the Hamiltonian, Cyclic Co-ordinates In Hamiltonian, **Routh's Procedure:** Introduction, Principle of Least Action, Action in Mechanics, Variation.	**CR 03**
4-1	**The Kinematics of Rigid Body Motion: Rigid body:** Introduction, Generalized co-ordinates of rigid body, Orthogonal Transformation, Properties of orthogonal transformation matrix, Infinitesimal Rotation, **Eulerian Angles :** Introduction, Moments of Inertia and Products of Inertia, Kinetic Energy of a rigid body with one point fixed, Components of angular velocity vector along body set of axes, **Cayley-Klein Parameters :** Introduction, Some Definitions, Matrix of transformation in terms of Cayley-Klein Parameters, Relation between the Cayley-Klein Parameters and Eulerian Angles.	**CR 04**

LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination			
CW- S24015		2015	YCMOU
Text-Books			
S24015-T01	Classical Mechanics Dr. L.N Kata (Dep.Mathematics)	Third 2013	Shivaji University, Kolhapur

SEMESTER 02

S24021: LINEAR ALGEBRA

PROGRAMME INFORMATION

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: http://www.ycmou.ac.in/ and http://ycmou.digitaluniversity.ac/
2	School	School of Architecture, Science and Technology
3	Discipline	Science
4	Level	PG
5	Course Used in	V57: M.Sc.(Maths)

COURSE INFORMATION

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	S24021	Linear Algebra	4	8	120	20	80	100	T

PRESUMED KNOWLEDGE AND LEARNING OBJECTIVES

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: • BSc/BA with Mathematics or equivalent from a recognized University/Board.	After successful completion of this course, student should be able to • •

UNITS

UN	Name of the Unit	CSs	Questions
01-01	**Linear Algebra**	CR 01 MLs 01-20	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
02-01	**Inner Product Spaces**	CR 02 MLs 21-40	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
03-01	**Canonical Forms**	CR 03 MLs 41-60	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
04-01	**Hermitian, Unitary and Normal Transformations**	CR 04 MLs 61-80	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR

DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	**Linear Algebra:** Definition, Homomorphism in Vector space, Linear Independent and Basic,Dual Space, Lemma, Anihilator of Anihilator.	CR 01
2-1	**Inner Product Spaces:** Definition, Linear Transformations, Characteristics Roots.	CR 03
3-2	**Canonical Forms:** Triangular Form, Nilpotent Transformations, A Decomposition of V : Jordan Form.	
4-1	**Hermitian, Unitary and Normal Transformations:** Bilinear Forms, Symmetric Bilinear Forms, Skew- Symmetric Bilinear Forms, Groups Preserving Bilinear Forms.	CR 04

LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination			
CW- S24021		2015	YCMOU
Text-Books			
S24021-T01	Linear Algebra Prof. M.T. Gophane	Second 2014	Shivaji University, Kolhapur

S24022: General Topology

Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: http://www.ycmou.ac.in/ and http://ycmou.digitaluniversity.ac/
2	School	School of Architecture, Science and Technology
3	Discipline	Science
4	Level	PG
5	Course Used in	V57: M.Sc.(Maths)

Course Information

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	S24022	General Topology	4	8	120	20	80	100	T

Presumed Knowledge and Learning Objectives

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: • BSc/BA with Mathematics or equivalent from a recognized University/Board.	After successful completion of this course, student should be able to • •

Units

UN	Name of the Unit	CSs	Questions
01-01 01-02 01-03 01-04 01-05	**Topological spaces** **Bases and subspaces** **Special subsets** **Different ways of defining topologies** **Continuous functions and Homeomorphisms**	**CR 01** **MLs** **01-20**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
02-01 02-02 02-03 02-04 02-05	**Compact space** **Connected space** **First axiom space** **Second axiom space** **Lindel of spaces**	**CR 02** **MLs** **21-40**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
03-01 03-02 03-03 03-04	**Separable spaces** **T_0- spaces** **T_1-spaces** **T_2-spaces**	**CR 03** **MLs** **41-60**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
04-01 04-02 04-03 04-04 04-05	**Regular spaces and T_3- spaces** **Normal spaces and T_4-spaces** **Completely Normal spaces and T_5-spaces** **Completely regular spaces and $T_{3\,1/2}$ spaces** **Product spaces and Quotient spaces**	**CR 04** **MLs** **61-80**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR

DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	**Topological spaces:** Definition and Examples, Definition, Some Special Topologies on Special sets, The set all topologies on X ($\neq \emptyset$), Topological spaces and metric spaces,	CR 01
1-2	**Bases and subspaces:** Base for a topology – Definition and Examples, Characterization of bases, Solved problems, Sub-base - Definition and Examples, Subspaces, Of a topological spaces.	
1-3	**Special subsets:** Derived set of a set, Closed sets, Closure of a set, Interior of a set, Exterior of a set, Boundary of set, Solved Problems.	
1-4	**Different ways of defining topologies:** Closure operator, Interior operator, Exterior operator, Neighborhood system.	
1-5	**Continuous functions:** Definition and examples, Characterizations, Properties, Homeomorphism, Solved Problem.	
2-1	**Compact space:** Definition and Examples, Characterizations and Properties, Special examples: ($R\varsigma\sim_u$)One point compactification, Locally compact spaces, Countably compact spaces	CR 02
2-2	**Connected space:** Separated sets, Connected sets, Solved Problems	
2-3	**First axiom space:** Definition and Examples, Properties, Sequentially continuity and first axiom.	
2-4	**Second axiom space:** Definition and properties of second axiom spaces, Sequentially compact spaces and second axiom spaces	
2-5	**Lindel of spaces:** Definition and Examples, Properties, Solved examples.	
3-1	**Separable spaces:** Definition and Examples, Properties, Solved problems	CR 03
3-2	**T_0- spaces:** Definition and Examples, Characterizations and Properties	
3-3	**T_1-spaces:** Definition and Examples, Characterizations and Properties, T_1 – spaces and countably compact spaces, T_1 – spaces and First axiom spaces (f.a.s), Solved problems.	
3-4	**T_2-spaces:** Definition and Examples, Characterizations and Properties, T_1 – spaces and compact spaces, Convergent sequences in T_2 – spaces.	
4-1	**Regular spaces and T3- spaces:** Definition and Examples of regular spaces, Characterizations and Properties of regular spaces, Definition and Examples of T_3 spaces, Properties of T_3 spaces, Solved Examples	CR 04
4-2	**Normal spaces and T4-spaces:** Definition and Examples of normal spaces, Characterizations and Properties of normal spaces, Definition and Properties of T_4 spaces, Solved Examples	
4-3	**Completely Normal and T5-spaces:** Definition and Examples, Properties and Characterizations, T_5 – spaces	
4-4	**Completely regular and $T_{3\ 1/2}$:** Definition and Examples, Characterizations and Properties, $T_{3\ 1/2}$ spaces or Tichonov spaces, Solved Problems,	
4-5	**Product spaces and Quotient spaces:** Definition and Basic concepts, Product Invariant Properties, Quotient topological.	

LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination			
CW- S24022		2015	YCMOU
Text-Books			
S24022-T01	General Topology Dr. Y.S. Power (Dept. Of Mathematics)	Second- 2014	Shivaji University, Kolhapur

S24023: Complex Analysis

Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: http://www.ycmou.ac.in/ and http://ycmou.digitaluniversity.ac/
2	School	School of Architecture, Science and Technology
3	Discipline	Science
4	Level	PG
5	Course Used in	V57: M.Sc.(Maths)

Course Information

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	S24023	Complex Analysis	4	8	120	20	80	100	T

Presumed Knowledge and Learning Objectives

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: • BSc/BA with Mathematics or equivalent from a recognized University/Board.	After successful completion of this course, student should be able to • •

Units

UN	Name of the Unit	CSs	Questions
01-01 01-02	**Complex Numbers** **Mobius Transformation**	CR 01 MLs 01-20	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
02-01 02-02 02-03	**Complex Integration** **Fundamental Theorem of Algebra and Maximum Modulus Theorem** **Winding Numbers and Cauchy's Integral Theorem**	CR 02 MLs 21-40	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
03-01 03-02	**Open Mapping and Gorse Theorem** **Laurent Series Development and Residue Theorem**	CR 03 MLs 41-60	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
04-01 04-02 04-03	**Rouche's Theorem and Maximum Modulus Theorem** **Schwarz's Lemma and its Consequences** **Spaces of Analytic functions and the Riemann Mapping Theorem**	CR 04 MLs 61-80	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR

DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	**Complex Numbers:** Introduction, Definition, Polar representation of complex numbers, Some Topological aspects	CR 01
1-2	**Mobius Transformation:** Introduction, Definition	
2-1	**Complex Integration:** Definition, Theorem, Lemma, Corollary	CR 02
2-2	**Fundamental Theorem of Algebra and Maximum Modulus Theorem:** Definition, Theorem, Corollary.	
2-3	**Winding Numbers and Cauchy's Integral Theorem:** Lemma, Theorem(First Version), Theorem (Second Version), Theorem Morera's Theorem, Singularities, Definition, Corollary	
3-1	**Open Mapping and Gorse Theorem:** Definition, Theorem, Corollary	CR 03
3-2	**Laurent Series Development and Residue Theorem:** Definition, Theorem, Uniqueness, Evaluation of real integrals using residue theorem	
4-1	**Rouche's Theorem and Maximum Modulus Theorem:** Definition (Meromorphic function), Theorem (Argument Principle), Rouche's Theorem, Corollary, Fundamental Theorem of Algebra, Maximum Modulus Theorems, Schwarz's Lemma.	CR 04
4-2	**Schwarz's Lemma and its Consequences :**Theorem	
4-3	**Spaces of Analytic functions and the Riemann Mapping Theorem:** The Space of Continuous Functions, Space of Analytic Functions The Riemann Mapping Theorem.	

LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination			
CW- S24023		2015	YCMOU
Text-Books			
S24023 -T01	Complex Analysis Dr. S. R. Chaudhari (Dept. Of Mathematics) Dr. U. H. Naik (Dept. Of Mathematics) Dr. Kishor D. Kucche(Dept. Of Mathematics)	Second 2014	Shivaji University, Kolhapur

S24024: Numerical Analysis

Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: http://www.ycmou.ac.in/ and http://ycmou.digitaluniversity.ac/
2	School	School of Architecture, Science and Technology
3	Discipline	Science -
4	Level	PG
5	Course Used in	V57: M.Sc.(Maths)

Course Information

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	S24024	Numerical Analysis	4	8	120	20	80	100	T

Presumed Knowledge and Learning Objectives

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: • BSc/BA with Mathematics or equivalent from a recognized University/Board.	After successful completion of this course, student should be able to • •

Units

UN	Name of the Unit	CSs	Questions
01-01	**Transcendental and Polynomial Equations**	CR 01 MLs 01-20	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
02-01	**System of Linear Algebraic Equations and Eigen Value Problems**	CR 01 MLs 21-40	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
03-01	**Interpolation, Differentiation and Integration**	CR 01 MLs 41-60	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
04-01	**Numerical Solution of Differential Equation**	CR 01 MLs 61-80	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR

Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
1-1	**Transcendental and Polynomial Equations:** Introduction, Definition, Bisection Method, Iteration Methods Based on First Degree Equation, Rate of Convergence, Iteration Methods, Polynomial Equations.	CR 01

2-1	**System of Linear Algebraic Equations and Eigen Value Problems:** Introduction, Iteration Methods, Matrix Factorization Method, Eigen Values and Eigen Vectors, Jacobi Method for Symmetric Matrices, Householder's Method for Symmetric Matrices, Power Method.	**CR 02**
3-1	**Interpolation, Differentiation and Integration:** Interpolation, Finite Difference Operators, Numerical Differentiation, Numerical Integration.	**CR 03**
4-1	**Numerical Solution of Differential Equation:** Introduction, Euler's Method, Order of Euler's Method, Runge-Kutta Method, Mid-Point Method, Range Kutta Methods, Runge Kutta Method for Four Slopes, System of Differential Equations.	**CR 04**

LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination			
CW- S24024		2015	YCMOU
Text-Books			
S24024-T01	Relativistic Mechanics Dr. (Mrs.) S. H. Thakar (Dept. of Mathematics) Dr. M. T. Gophane (Dept. of Mathematics)	First 2014	Shivaji University, Kolhapur

S24025: Differential Geometry

Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: http://www.ycmou.ac.in/ and http://ycmou.digitaluniversity.ac/
2	School	School of Architecture, Science and Technology
3	Discipline	Science
4	Level	PG
5	Course Used in	V57: M.Sc.(Maths)

Course Information

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	S24025	Differential Geometry	4	8	120	20	80	100	T

Presumed Knowledge and Learning Objectives

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: • BSc/BA with Mathematics or equivalent from a recognized University/Board.	After successful completion of this course, student should be able to • •

Units

UN	Name of the Unit	CSs	Questions
01-01	**Euclidean Space**	CR 01 MLs 01-20	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
02-01	**The Frenet Formulae**	CR 02 MLs 21-40	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
03-01	**Calculus On Surface**	CR 03 MLs 41-60	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
04-01	**Shape Operator**	CR 04 MLs 61-80	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR

Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR

1-1	**Euclidean Space:** Tangent Vector Field, Directional Derivative, Properties of Directional Derivative, Curve in R^3, Geometrical interpretation, Reparametrization of Curves, Regular Curves, Differential Forms, Exterior Product , Exterior Derivative. Dot Product , Norm of $_p$, Euclidean Distance, Speed of Curve, A Vector Field on a Curve, Acceleration of Curve, Parallel Vector Field on A Curve.	**CR 01**
2-1	**The Frenet Formulae:** Introduction, The Frenet Formulae for Unit Speed Curve, Frenet Approximation of Curve, Frenet Formulae for Arbitrary Speed Curve, Cylindrical Helix, Covariant Derivative with respect to Tangent Vector, Covariant Derivative, Covariant Derivative of Vector Field w.r.t. a Vector Field, Isometries of R^3 (Rigit Motion), Orthogonal Transformation.	**CR 02**
3-1	**Calculus On Surface**: Introduction, Preliminaries, Regular Mapping and Coordinate Patch, Surface, Surface of Revolution. Patch Computation, Parametrization of The Region X(D) in M, Differentiable Functions and Tangent Vectors.	**CR 03**
4-1	**Shape Operator**: Introduction, Shape Operator of Surface, Normal Curvature, Gaussian and Mean Curvature. Formula for the Shape Operator when surface given in the form M : $g(x,y,z)$ = **C,** Special Curves in a Surface, Principal Curves, Asymptotic Directions.	**CR 04**

LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination			
CW- S24025		2015	YCMOU
Text-Books			
S24025-T01	Differential Geometry Dr. L. N. Katkar (Dept. of Mathematics) Prof. M. S. Bapat (Willingdon College Sangli)	Second 2014	Shivaji University, Kolhapur

SEMESTER 03

S24031: FUNCTIONAL ANALYSIS

PROGRAMME INFORMATION

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: http://www.ycmou.ac.in/ and http://ycmou.digitaluniversity.ac/
2	School	School of Architecture, Science and Technology
3	Discipline	Science
4	Level	PG
5	Course Used in	V57: M.Sc.(Maths)

COURSE INFORMATION

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	S24031	Functional Analysis	4	8	120	20	80	100	T

PRESUMED KNOWLEDGE AND LEARNING OBJECTIVES

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: • BSc/BA with Mathematics or equivalent from a recognized University/Board	After successful completion of this course, student should be able to • •

UNITS

UN	Name of the Unit	CSs	Questions
01-01 01-02	Normed Linear Spaces, Banach Spaces Hahn-Banach Theorem	CR 01 MLs 01-20	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
02-01 02-02	Open Mapping Theorem Hilbert Spaces	CR 02 MLs 21-40	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
03-01 03-02	Bessel Inequalities, Fourier Expansions and Conjugate Space The Adjoint Operators and Special Type of Operators	CR 03 MLs 41-60	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
04-01 04-02	Finite Dimensional Spectral Theory Contraction Mapping Principle	CR 04 MLs 61-80	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR

DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	**Normed Liner Spaces, Banach Spaces:** Introduction, Warm Up, Normed Liner Spaces, Quotient Space, Continuous Linear Transformation, Equivalent Norms	CR 01
1-2	**Hahn-Banach Theorem:** Introduction, Poset, Maximal Element, Continuous Linear Functional, Zorn's Lemma, Lemma Hahn-Banach Theorem, Consequences of Hahn-Banach Theorem, The Dual Space of L^p ,(Bidual) Space/ Second Dual Space of a nls Natural Imbedding/ Canonical mapping of N into N**, Reflexive Space, Strong Topology on N, Weak Topology on N.	
2-1	**Open Mapping Theorem:** Introduction, Lemma, Open Mapping Theorem (Banach Schauder Theorem), Consequence (Inverse Mapping Theorem), Closed Graph Theorem, Projections of Banach Spaces, Uniform Boundedness Theorem (Principle) [Banach Steinhaus Theorem], Conjugate Adjoint Operator.	CR 02
2-2	**Hilbert Spaces:** Introduction, Schwarz's Inequality, Parallelogram Law, X-Real IPS, Theorem (Von Neumann), Hilbert Space, Orthogonal Complements, Orthogonal Complement of Subset, Projection Theorem.	
3-1	**Bessel Inequalities, Fourier Expansions and Conjugate Space:** Introduction, Generalized Bessel's Inequality, Complete Orthonormal Set in Hilbert Space, Characteristization Complete Orthonormal Set, Continuous Linear Functional on Hilbert Space H, Riesz Representation Theorem.	CR 03
3-2	**The Adjoint Operators and Special Type of Operators:** Introduction, Properties of adjoint Operator, Projection on Hilbert Space, Orthogonal Projection or Perpendicular Projection, Invariant Subspace Under Operator.	
4-1	**Finite Dimensional Spectral Theory:** Introduction, Eigenvalues and Eigenvectors, Eigen Space, Matrix of an operator, Spectrum an operator, Spectral Resolution.	CR 04
4-2	**Contraction Mapping Principle:** Introduction, Fixed Point, Contraction Mapping, Theorem (Banach Fixed Point Theorem)	

LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination			
CW-S24031		2015	YCMOU
Text-Books			
S24031-T01	Functional Analysis Dr. M. S. Chaudhary	First 2009	Shivaji University, Kolhapur

S24032: Advanced Discrete Mathematics

Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: http://www.ycmou.ac.in/ and http://ycmou.digitaluniversity.ac/
2	School	School of Architecture, Science and Technology
3	Discipline	Science
4	Level	PG
5	Course Used in	V57: M.Sc.(Maths)

Course Information

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	S24032	Advanced Discrete Mathematics	4	8	120	20	80	100	T

Presumed Knowledge and Learning Objectives

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: • BSc/BA with Mathematics or equivalent from a recognized University/Board	After successful completion of this course, student should be able to • •

Units

UN	Name of the Unit	CSs	Questions
01-01 01-02	**Graph Theory** **Trees**	CR 01 MLs 01-20	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
02-01 02-02	**Lattice Theory** **Boolean Algebra**	CR 02 MLs 21-40	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
03-01 03-02	**Recurrence Relations** **Generating Functions**	CR 03 MLs 41-60	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
04-01 04-02	**Combinotorics** **Automata and Languages**	CR 04 MLs 61-80	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR

DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	**Graph Theory:** Introduction, Graphs as Models, The Matrix Representation of Graphs, Fusion,	CR 01
1-2	**Trees:** Introduction, Trees and Connectivity, Connector Problems, Kruskals Algorithm, Prims Algorithm	
2-1	**Lattice Theory:** Introduction, Theorem, Product of Two Posets-Theorem, Lattices, Distributivity and Modularity, Lemma, Ideals, Dual Ideals	CR 02
2-2	**Boolean Algebra:** Introduction, Theorem, Simplification of Circuits, Designing of Switching Circuits.	
3-1	**Recurrence Relations:** Introduction, Linear Difference Equation with Constant Coefficients.	CR 03
3-2	**Generating Functions:** Introduction, Generating Functions, Basic Properties of G.F.	
4-1	**Combinatorics:** Introduction, Elementary Counting Principles, Multiplication Principle, Cardinality of Finite Set, Pigeon-Hole Principle	CR 04
4-2	**Automata and Languages:** Introduction, Alphabet, String, Language, Concatenation, Closure Operation, Finite Automata (Deterministic Finite Automata) (DFA), Non Deterministic Finite Automata (NFA), Finite Automata with-Moves, Regular Expression.	

LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination			
CW-S24032		2015	YCMOU
Text-Books			
S24032-T01	Advanced Discrete Mathematics Dr. C. S. Manjarekar	First 2009	Shivaji University, Kolhapur

S24033: Number Theory

Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: http://www.ycmou.ac.in/ and http://ycmou.digitaluniversity.ac/
2	School	School of Architecture, Science and Technology
3	Discipline	Science -
4	Level	PG
5	Course Used in	V57: M.Sc.(Maths)

Course Information

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	S24033	Number Theory	4	8	120	20	80	100	T

Presumed Knowledge and Learning Objectives

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: • BSc/BA with Mathematics or equivalent from a recognized University/Board	After successful completion of this course, student should be able to • •

Units

UN	Name of the Unit	CSs	Questions
01-01 01-02	**Divisibility** **Prime Numbers and Their Distribution**	**CR 01** **MLs** **01-20**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
02-01 02-02	**Congruence Relation** **Fermat's-Theorem and Applications**	**CR 02** **MLs** **21-40**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
03-01 03-02	**Number Theoretic Functions** **Euler's Function**	**CR 03** **MLs** **41-60**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
04-01 04-02	**Primitive Roots** **Quadratic Reciprocity**	**CR 04** **MLs** **61-80**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR

DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	**Divisibility:** Introduction, Division Algorithm, Uniqueness of q and r, To establish the Second Assertion of the Theorem.	CR 01
1-2	**Prime Numbers and Their Distribution:** Introduction, Prime Numbers, Prime and Their Distribution, The Goldbach Conjecture	
2-1	**Congruence Relation:** Introduction, Definition, Theorem, Corollary	CR 02
2-2	**Fermat's-Theorem and Applications:** Introduction, Theorem, Corollary, Alternative Proof	
3-1	**Number Theoretic Functions:** Introduction, Lemma, Theorem,Mobius Inversion Formula	CR 03
3-2	**Euler's Function:** Introduction, Lemma, Gauss Theorem	
4-1	**Primitive Roots:** Introduction, Composite Number having Primitives, Lemma, Theory of Indices	CR 04
4-2	**Quadratic Reciprocity:** Introduction, Definition, Theorem, Corollary	

LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination			
CW-S24033		2015	YCMOU
Text-Books			
S24033-T01	Number Theory Dr. C. S. Manjarekar	First 2009	Shivaji University, Kolhapur

S24034: Integral Equations

Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: http://www.ycmou.ac.in/ and http://ycmou.digitaluniversity.ac/
2	School	School of Architecture, Science and Technology
3	Discipline	Science
4	Level	PG
5	Course Used in	V57: M.Sc.(Maths)

Course Information

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	S24034	Integral Equations	4	8	120	20	80	100	T

Presumed Knowledge and Learning Objectives

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: • BSc/BA with Mathematics or equivalent from a recognized University/Board	After successful completion of this course, student should be able to • •

Units

UN	Name of the Unit	CSs	Questions
01-01 01-02 01-03	**Integral Equation** **Conversion of ODE to Integral Equation** **Fredholm Integral Equations with Separable Kernel**	**CR 01** **MLs** **01-20**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
02-01 02-02 02-03	**Eigen Values and Eigen Functions** **Method of Successive Approximation** **Volterra Integral Equation**	**CR 02** **MLs** **21-40**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
03-01 03-02	**Symmetric Kernels** **Hibert Theorem and its Consequences**	**CR 03** **MLs** **41-60**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
04-01 04-02	**Integral Transform Method** **Greens Function**	**CR 04** **MLs** **61-80**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR

Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
1-1	**Integral Equation:** Definition, Classification of Integral Equation, General form of Linear Integral Equation, Classification of Linear Integral Equation, Solution of Integral Equation, Some Problem which Gives Rise to Integral Equation	CR 01
1-2	**Conversion of ODE to Integral Equation:** Differentiation under Integral Sign, Identity for Converting Multiple Integral into Single Ordinary Integral, Conversion of Initial Value Problem to Integral Equation, Conversion of Boundary Value Problem to Integral Equation, Conversion of Integral Equation to ODE.	
1-3	**Fredholm Integral Equations with Separable Kernel:** Solution of fredholm Integral Equation with Separebic Kernel, Fredholm Theorem, Transpose Integral Equation.	
2-1	**Eigen Values and Eigen Functions:** Eigen Values and Eigen Functions, Eigen Values and Eigen Functions of the Homogeneous Fredholm Integral, Equation by reducing it to sturm Liouville Problem.	CR 02
2-2	**Method of Successive Approximation:** Successive approximation for Fredholm Integral Equation, Resolvent Kernel of Fredholm Integral Equation, Solution of Fredholm Integral Equation by Method of Resolvent Kernel, Solution of Fredholm Integral Equation by Method of Iteration, Successive approximation for Volterra Integral Equation	
2-3	**Volterra Integral Equation:** Definition and Properties, Solution of Volterra Integral Equation by Differentiation, Successive approximation for Volterra Integral Equation, Resolvent Kernel of Volterra Integral Equation, Solution of Volterra Integral Equation by Method of Resolvent Kernel, Solution of Volterra Integral Equation by Iteration Method.	
3-1	**Symmetric Kernels:** Preliminaries, Symmetric Kernel and Properties, Orthonormal Set, Fundamental Properties of Eigen values and Eigen Function for Symmetric Kernel, Expansion of Symmetric Kernel in Eigen Function.	CR 03
3-2	**Hibert Theorem and its Consequences:** Hibert-Schmidt Theorem, Application of Hilbert-Schmidt Theorem, Solution of symmetric Integral Equation by Hilbert- Schmidt Theorem	
4-1	**Integral Transform Method:** Laplace Transform, Solution of Volterra Integral Equation with Convolution Type Kernel, Solution of Integrals- Differential by Laplace Transform Method, Solution of Able Integral Equation by Laplace Transform Method, Fourier Transform, Solution by Fourier Transform Method.	CR 04
4-2	**Greens Function:** Introduction, Motivation, Definition of Greens Function, Existence and Uniqueness Theorem, Construction of Greens Function, Solution or Conversion of BVP to Integral Equation by using Greens Function.	

Learning Resource Details

LR Code	Title Author	Edition Year	ISBN Publisher
Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination			
CW-S24034		2015	YCMOU
Text-Books			
S24034-T01	Integral Equations Dr. C. S. Manjarekar	First 2009	Shivaji University, Kolhapur

S24035: Operation Research-I

Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: http://www.ycmou.ac.in/ and http://ycmou.digitaluniversity.ac/
2	School	School of Architecture, Science and Technology
3	Discipline	Science
4	Level	PG
5	Course Used in	V57: M.Sc.(Maths)

Course Information

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	S24035	Operation Research-I	4	8	120	20	80	100	T

Presumed Knowledge and Learning Objectives

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: • BSc/BA with Mathematics or equivalent from a recognized University/Board	After successful completion of this course, student should be able to • •

Units

UN	Name of the Unit	CSs	Questions
01-01 01-02	**Convex Sets and Functions** **Linear Programming**	**CR 01** **MLs** **01-20**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
02-01 02-02	**D-Generacy, Duality and Revised Simplex Method** **Integer Programming**	**CR 02** **MLs** **21-40**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
03-01 03-02	**Dynamic Programming** **Applications To Linear Programming**	**CR 03** **MLs** **41-60**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
04-01 04-02	**Non-Liner Programming** **Wolfe's and Beale's Methods**	**CR 04** **MLs** **61-80**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR

DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	**Convex Sets and Functions:** Introduction, Convex Sets and Their Properties, Hyperplanes and Half Spaces, Supporting and Separating Hyperplanes, Convex Functions, Local and Global Extreme.	CR 01
1-2	**Linear Programming:** Introduction, The General L.P.P., Basic Solution, Conversely, Reduction of any Feasible Solution to a Basic Feasible Solution, To Find Incoming Vector.	
2-1	**D-Generacy, Duality and Revised Simplex Method:** Introduction, Duality, Standard form of the Primal, Relationship between two problems (Primal and dual), Revised Simplex Method, To Obtain Inverse of Initial Basis Matrix an Initial BFS	CR 02
2-2	**Integer Programming:** Introduction, Gomory's All Integer Cutting Plane Method, Examples, Geometrical Interpretation of Gomory's Cutting Plane Method, Branch and Bound Method, Steps of Branch and Bound Algorithm.	
3-1	**Dynamic Programming:** Introduction, Characteristics of Dynamic Programming, Examples.	CR 03
3-2	**Applications To Linear Programming:** Introduction, Solution of Linear Programming Problem as a Dynamic Programming Problem, Examples, Application to Inventory	
4-1	**Non-Liner Programming:** Introduction, Unconstrained External Problem, Theorem, Lagrange's Method of Undetermined Multipliers, Necessary and Sufficient Conditions for Optimization of an Objective Function, Kuhn- Tucker's Conditions	CR 04
4-2	**Wolfe's and Beale's Methods:** Introduction, Quadratic Program, Wolfe's Modified Simplex Method, Illustrative Examples on Wolfe's Method, Beale's Method, Illustrative Examples on Beale's Method.	

LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination			
CW- S24035		2015	YCMOU
Text-Books			
S24035-T01	Operation Research-I Dr. L. N. Katkar	First 2009	Shivaji University, Kolhapur

SEMESTER 04

S24041: MEASURE AND INTEGRATION

PROGRAMME INFORMATION

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: http://www.ycmou.ac.in/ and http://ycmou.digitaluniversity.ac/
2	School	School of Architecture, Science and Technology
3	Discipline	Science
4	Level	PG
5	Course Used in	V57: M.Sc.(Maths)

COURSE INFORMATION

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	S24041	Measure and Integration	4	8	120	20	80	100	T

PRESUMED KNOWLEDGE AND LEARNING OBJECTIVES

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: • BSc/BA with Mathematics or equivalent from a recognized University/Board	After successful completion of this course, student should be able to • •

UNITS

UN	Name of the Unit	CSs	Questions
01-01 01-02	**Measure Space, Measurable Functions** **Integration and General Convergence Theorems**	CR 01 MLs 01-20	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
02-01 02-02	**Signed Measure** **The Radom- Nikodym Theorem**	CR 02 MLs 21-40	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
03-01 03-02	**Product Measures** **Outer Measure**	CR 03 MLs 41-60	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
04-01 04-02	**Inner Measure** **L^p-Spaces**	CR 04 MLs 61-80	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR

DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	**Measure Space, Measurable Functions:** Introduction, Measurable Functions, Theorem	CR 01
1-2	**Integration and General Convergence Theorems:** Introduction, Theorem: Fatou's Lemma, Theorem: Monotone Convergence Theorem, Theorem: Lebesgue Convergence Theorem.	
2-1	**Signed Measure:** Introduction, Definition, Lemma, Hann Decomposition Theorem, and Theorem.	CR 02
2-2	**The Radom- Nikodym Theorem:** Introduction, Lemma, Theorem, Uniqueness, Lebesgue Decomposition Theorem.	
3-1	**Product Measures:** Introduction, Product Measure, Lemma, Proposition, Integration on Product Spaces, Fubini's Theorem, Tonelli's Theorem	CR 03
3-2	**Outer Measure:** Introduction, Definition, Theorem.	
4-1	**Inner Measure:** Introduction, Definition, Theorem.	CR 04
4-2	**L^p-Spaces:** Introduction, Definition, Holder Inequality, Minkowski Inequality, Proposition, Lemma, Riesz Representation Theorem.	

LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination			
CW-S24041		2015	YCMOU
Text-Books			
S24041-T01	Measure and Integration Dr. S. R. Chaudhari	First 2009	Shivaji University, Kolhapur

S24042: Partial Differential Equations

Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: http://www.ycmou.ac.in/ and http://ycmou.digitaluniversity.ac/
2	School	School of Architecture, Science and Technology
3	Discipline	Science
4	Level	PG
5	Course Used in	V57: M.Sc.(Maths)

Course Information

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	S24042	Partial Differential Equations	4	8	120	20	80	100	T

Presumed Knowledge and Learning Objectives

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: • BSc/BA with Mathematics or equivalent from a recognized University/Board	After successful completion of this course, student should be able to • •

Units

UN	Name of the Unit	CSs	Questions
01-01 01-02	**First Order Partial Differential Equations** **Liner Equation of the First Order**	**CR 01** **MLs** **01-20**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
02-01 02-02	**Compatible Systems of First Order Partial Differential Equation** **The Cauchy Problem**	**CR 02** **MLs** **21-40**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
03-01 03-02	**Second Order Partial Differential Equations** **Heat Conduction Problem**	**CR 03** **MLs** **41-60**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR
04-01 04-02	**Laplace Equation** **Riemann's Method of Solution of Linear Hyperbolic Equation**	**CR 04** **MLs** **61-80**	Student is required to answer 4 of 5 SAQ, **each** of 5 marks, on **each** CR

DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	**First Order Partial Differential Equations:** Introduction, Curves and Surfaces, Parametric Equations of a Surface, A Curve Through Surfaces, Direction Cosines of a Line Passing Through two Points, The Direction Cosines if the Tangent to the Curve, Direction Ration of the Normal to the Surface, Equation of a Line when two Surfaces are Given, Partial Differential Equation, Classification of First Order Partial Differential Equations, Classification of Integrals.	CR 01
1-2	**Liner Equation of the First Order:** Introduction, Theorem, Pfaffian Differential Equations, Criteria of Integrability of a Pfaffian Differential Equation.	
2-1	**Compatible Systems of First Order Partial Differential Equation:** Introduction, Charpit's Method, Same Standard Types of p.d.e. , Jacobi's Method, Jacobi's Method to Solve a Non-Linear p.d.e. in two Variables.	CR 02
2-2	**The Cauchy Problem:** Introduction, Integral Surface Through a Given Curve for a Linear Partial Differential Equations, Integral Surface Through a Given Curve for a Non-Linear Partial Differential Equations, Integral Surface Through a Given Curve by a Method of Characteristics.	
3-1	**Second Order Partial Differential Equations:** Introduction, Solution of the Equation, Origin of the Partial Differential Equation, One Dimensional Wave Equation, Heat Conduction Equation, Classification of Second Order Partial Differential Equation, Physical Meaning of the Solution of the Wave Equation, Vibration of a Semi-Infinite String (one end point is fixed), Vibration of a String of Finite Length, Vibration of a String of Finite Length (Method of Separation of Variables), Uniqueness of Solution of Wave Equation.	CR 03
3-2	**Heat Conduction Problem:** Introduction, Uniqueness of the Solution, Heat Conduction-Infinite Rod, Families of Equipotential Surfaces.	
4-1	**Laplace Equation:** Introduction, Boundary Value Problems, Interior Dirichlet Problem for a Circle, The Dirichlet Exterior Problem for a Circle, Interior Neumann Problem for a Circle, Exterior Neumann Problem for a Circle, Interior Dirichlet Problem for a Rectangle, The Neumann Problem for a Rectangle, The Dirichlet Problem for the Upper Half Plane, The Neumann Problem for the Upper Half Plane.	CR 04
4-2	**Riemann's Method of Solution of Linear Hyperbolic Equation:** Introduction, Harnack's Theorem.	

LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination			
CW-S24042		2015	YCMOU
Text-Books			
S24042-T01	Partial Differential Equations Dr. L. N. Katkar	First 2009	Shivaji University, Kolhapur

S24043: Riemannian Geometry-I

Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: http://www.ycmou.ac.in/ and http://ycmou.digitaluniversity.ac/
2	School	School of Architecture, Science and Technology
3	Discipline	Science
4	Level	PG
5	Course Used in	V57: M.Sc.(Maths)

Course Information

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	S24043	Riemannian Geometry-I	4	8	120	20	80	100	T

Presumed Knowledge and Learning Objectives

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: • BSc/BA with Mathematics or equivalent from a recognized University/Board	After successful completion of this course, student should be able to • •

Units

UN	Name of the Unit	CSs	Questions
01-01 01-02	**Some Preliminaries and Tensor** **N-Ply Orthogonal System of Hyper surfaces and Orthogonal Ennuple**	CR 01 MLs 01-20	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
02-01 02-02	**Euclidean Space of M-Dimension** **Christoffel's Three-Index Symbols and Covariant Differentiation**	CR 02 MLs 21-40	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
03-01 03-02	**Divergence and Curl of a Vector and Laplacian Operator** **Curvature of a curve, Geodesics, Parallelism of Vectors**	CR 03 MLs 41-60	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
04-01 04-02	**Geodesic Co-ordinate System, Riemannian Co-ordinate** **Parallelism of a Vector**	CR 04 MLs 61-80	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR

DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	**Some Preliminaries and Tensor:** Introduction, Co-ordinates of a Point in a Given Space, Space of n-dimensions, Algebra of Tensors.	
1-2	**N-Ply Orthogonal System of Hypersurface and Orthogonal Ennuple:** Introduction, Length of a Curve and Magnitude of a Vector, Angle Between two Hypersurface, Co-ordinate Hypersurface, Angle Between two Co-ordinate Hypersurface, Orthogonality Consition, N-Ply Orthogonal System of Hypersurface, Congruence, Orthogonal Ennuple, Principle Directions for a Symmetric Covariant Tensor of Second Order.	CR 01
2-1	**Euclidean Space of M-Dimension:** Introductions, Components of Reciprocal Tensor, Cartesian Co-ordinates, Riemannian Subspace of an Euclidean Space.	
2-2	**Christoffel's Three-Index Symbols and Covariant Differentiation:** Introduction, Christoffel Symbols, Covariant Derivative of a Tensor Field, Intrinsic Derivative (Derived Vector), Tender of a Vector.	CR 02
3-1	**Divergence and Curl of a Vector and Laplacian Operator:** Introduction, Divergence of a Vector, Curl of a Vector, Laplacian Operator.	
3-2	**Curvature of a curve, Geodesics, Parallelism of Vectors:** Introduction, First Curvature (Geoderic Curvature) Vector, First Curvature (Geoderic Curvature) of the Curve, Principle Normal, Geodesics, Differential Equations of Geodesic on a $V_{n.}$	CR 03
4-1	**Geodesic Co-ordinate System, Riemannian Co-ordinate:** Introduction, Geodesic Co-ordinate System, Necessary Part, Riemannian Co-ordinates, Conversely, Geodesic form of the Line Element.	
4-2	**Parallelism of a Vector:** Introduction, Parallel Displacement and Riemannian Tensor, Parallelism f a Vector of Variable Magnitude, Subspace of a Riemannian Manifold, Parallelism in Subspace.	CR 04

LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination			
CW-S24043		2015	YCMOU
Text-Books			
S24043-T01	Riemannian geometry-I Dr. L. N. Katkar	First 2016	Shivaji University, Kolhapur

S24044: Riemannian Geometry-II

Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: http://www.ycmou.ac.in/ and http://ycmou.digitaluniversity.ac/
2	School	School of Architecture, Science and Technology
3	Discipline	Science -
4	Level	PG
5	Course Used in	V57: M.Sc.(Maths)

Course Information

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	S24044	Riemannian Geometry-II	4	8	120	20	80	100	T

Presumed Knowledge and Learning Objectives

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: • BSc/BA with Mathematics or equivalent from a recognized University/Board	After successful completion of this course, student should be able to • •

Units

UN	Name of the Unit	CSs	Questions
01-01 01-02	**Ricci's Coefficients of Rotation** **Canonical Congruences**	CR 01 MLs 01-20	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
02-01 02-02	**Riemann Curvature Tensor** **Curvature of a Riemannian Space**	CR 02 MLs 21-40	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
03-01 03-02	**Einstein Space** **Hypersurfaces**	CR 03 MLs 41-60	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
04-01 04-02	**Curvature of a Curve in A Hypersurface and Normal Curvature of a Hypersurface** **Gauss and Codazzi Equations for a Hypersurface**	CR 04 MLs 61-80	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR

DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	**Ricci's Coefficients of Rotation:** Introduction, Ricci's Coefficients of Rotation, Curvature of a Congruence, Geodesic Congruence, Normal Congruence, Curl of a Congruence.	CR 01
1-2	**Canonical Congruences:** Introduction, Theorem, Conversely, Corollary.	
2-1	**Riemann Curvature Tensor:** Introduction, Riemann Curvature Tensor, Second Order Covariant Derivative of a Tensor of Rank two, Properties of Riemann Curvature Tensor, Ricci Tensor, Bianchi Identities, Contracted Bianchi Identities.	CR 02
2-2	**Curvature of a Riemannian Space:** Introduction, Riemannian Co-ordinates, Relation between Christoffel Symbols of V_n and V_m in which V_n is Immersed, Riemannian Curvature of a Space at a Point, Expression Riemannian Curvature, Flat Space, Mean Curvature of a Space for a Given Direction, Riccis's Principle Directions.	
3-1	**Einstein Space:** Introduction, Definition.	CR 03
3-2	**Hypersurfaces:** Introduction, Tensor Derivative (Generalised Covariant Differentiation), Gauss's Formulae.	
4-1	**Curvature of a Curve in A Hypersurface and Normal Curvature of a Hypersurface:** Introduction, Meunier's Theorem, Generalization of Dupin's Theorem,Some Definitions, Conjugate Directions and Asymptotic Directions in a Hypersurface, Euler's Formula, Umbilical Points, Totally Geodesic Hypersurface, Tensor Derivative of the Unit Normal.	CR 04
4-2	**Gauss and Codazzi Equations for a Hypersurface:** Introduction, Hypersurface in Euclidean Space, Riemannian Curvature of a Hypersurface in a Euclidean Space, Hyperplanes and Hyperspaces, Geodesics in a Space of Positive Constant Curvature, Subspaces of a Riemannian Space, Curvature of a Curve in a Subspace.	

LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination			
CW-S24044		2015	YCMOU
Text-Books			
S24044-T01	Riemannian geometry-II Dr. L. N. Katkar	First 2009	Shivaji University, Kolhapur

S24045: OPERATION RESEARCH-II

PROGRAMME INFORMATION

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: http://www.ycmou.ac.in/ and http://ycmou.digitaluniversity.ac/
2	School	School of Architecture, Science and Technology
3	Discipline	Science -
4	Level	PG
5	Course Used in	V57: M.Sc.(Maths)

COURSE INFORMATION

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	S24045	Operation Research-II	4	8	120	20	80	100	T

PRESUMED KNOWLEDGE AND LEARNING OBJECTIVES

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: • BSc/BA with Mathematics or equivalent from a recognized University/Board	After successful completion of this course, student should be able to • •

UNITS

UN	Name of the Unit	CSs	Questions
01-01 01-02	Replacement Problems Problems in Mortality	CR 01 MLs 01-20	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
02-01 02-02	Inventory Control Probabilistic Models	CR 02 MLs 21-40	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
03-01 03-02	Queing Theory-I Queing Theory-II	CR 03 MLs 41-60	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR
04-01 04-02	Information Theory Pert and CRM	CR 04 MLs 61-80	Student is required to answer 4 of 5 SAQ, each of 5 marks, on each CR

DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	**Replacement Problems:** Introduction, Types of Replacement Situation To find the best Replacement age of a Machine when (i) Its Maintenance Cost is given by a function Increasing with time, (ii) Its Scrap Value is Constant and (iii) The Money Value is not increased. Solution To find the Interval of Optimum Replacement	CR 01
1-2	**Problems in Mortality:** Introduction, Staffing Problem, Mortality Tables, Solution.	
2-1	**Inventory Control:** Introduction, Definitions and Related Concepts, Model-I, Model-II, Model-III, Model-IV, Model-V, Model-VI.	CR 02
2-2	**Probabilistic Models:** Introduction, Model VII, Model VIII, Model IX, Model VII, Model X.	
3-1	**Queing Theory-I:** Introduction, Basic Definitions and Notations, Classification of Queuing Models, Model I: (M/M/1): (∞/FCFS) (Birth and Death Model), Model II: General Erland Queuing Model.	CR 03
3-2	**Queing Theory-II:** Introduction, Model III: (M/M/1): (N/FCFS), Model IV: (M/M/S): (∞/FCF∞), Model V: (M/E_k/1): (∞/FCFS), Model VI: (M/E_k/1): (1/FCFS), Machine Repair Problem, Model VII (M/M/R): (K/GD), K‹R, Model VIII: Power Supply Model.	
4-1	**Information Theory:** Information, Description of a Communication System, A Quantitative Measure of Information, A Binary Unit of Information, Measure of Uncertainty or Entropy, Properties of Average Measure of Uncertainty or Entropy, Important Relations for Various Entropies.	CR 04
4-2	**Pert and CRM:** Introduction, Basic Steps in PERT/CRM Techniques, Network Diagram Representation, Labelling Fulkerson's 'I-J' Rule, Time Estimates and Critical Path in Network Analysis, Determination of Critical Path, Project Evaluation and Review Technique (PERT).	

LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination			
CW-S24044		2015	YCMOU
Text-Books			
S24045-T01	Operation Research-II Dr. C. S Manjarekar	First 2009	Shivaji University, Kolhapur