STATE MODEL SYLLABUS FOR
UNDER GRADUATE
COURSE IN MATHEMATICS
(Bachelor of Science Examination)

UNDER
CHOICE BASED CREDIT SYSTEM

COURSE STRUCTURE FOR MATHEMATICS HONORS

Semester	Course	Course Name	Credits
I	AECC-I	AECC-I	04
	C-I	Calculus	04
	C-I	Practical	02
	C-II	Discrete Mathematics	05
	C-II	Tutorial	01
	GE-I	GE-I	05
	GE-I	Tutorial	01
			22
II	AECC-II	AECC-II	04
	C-III	Real Analysis	05
	C-III	Tutorial	01
	C-IV	Differential equations	04
	C-IV	Practical	02
	GE-II	GE-II	05
	GE-II	Tutorial	01
			22
III	C-V	Theory of Real functions	05
	C-V	Tutorial	01
	C-VI	Group Theory-I	05
	C-VI	Tutorial	01
	C-VII	Partial differential equations and system of ODEs	04

and
world
gram at
ursuing
titative
of the
strong
matical

Semester	Course	Course Name	Credits
	C-VII	Practical	02
	GE-III	GE-III	05
	GE-III	Tutorial	01
	SECC-I	SECC-I	04
			28
IV	C-VIII	Numerical Methods and Scientific Computing	04
	C-VIII	Practical	02
	C-IX	Topology of Metric spaces	05
	C-IX	Tutorial	01
	C-X	Ring Theory	05
	C-X	Tutorial	01
	GE-IV	GE-IV (Theory)	05
	GE-IV	Tutorial	01
	SECC-II	SECC-II	04
			28
Semester	Course	Course Name	Credits
V	C-XI	Multivariable Calculus	05
	C-XI	Tutorial	01
	C-XII	Linear Algebra	05
	C-XII	Tutorial	01
	DSE-I	Linear Programming	05
	DSE-I	Tutorial	01
	DSE-II	Probability and Statistics	05
	DSE-II	Tutorial	01

			24
VI	C-XIII	Complex analysis	05
	C-XIII	Tutorial	01
	C-XIV	Group Theory-II	05
	C-XIV	Tutorial	01
	DSE-III	Differential Geometry	05
	DSE-III	Tutorial	01
	DSE-IV	Number Theory/Project	06
			24
		TOTAL	148

Prayak
24.07.19

24.7.19

24.7.19

24.7.19

HONOURS PAPERS:

Core course – 14 papers

Discipline Specific Elective – 4 papers (out of the 5 papers suggested)

Generic Elective for non Mathematics students – 4 papers. Incase University offers 2 subjects

GE, then papers 1 and 2 will be the GE paper.

Marks per paper –

For practical paper: Midterm : 15 marks, End term : 60 marks, Practical- 25 marks

For non practical paper: Mid term : 20 marks, End term : 80 marks

 Total – 100 marks   Credit per paper – 6

Teaching hours per paper –

Practical paper-40 hour theory classes + 20 hours Practical classes

Non Practical paper-50 hour theory classes + 10 hours tutorial

CORE PAPER-1

CALCULUS

Objective: The main emphasis of this course is to equip the student with necessary analytic
technical skills to handle problems of mathematical nature as well as practical problems. M
precisely, main target of this course is to explore the different tools for higher order derivativ
to plot the various curves and to solve the problems associated with differentiation
integration of vector functions.

Excepted Outcomes: After completing the course, students are expected to be able to
Leibnitz's rule to evaluate derivatives of higher order, able to study the geometry of vari
types of functions, evaluate the area, volume using the techniques of integrations, able
identify the difference between scalar and vector, acquired knowledge on some the b
properties of vector functions.

UNIT-I

Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to problems of the type $e^{ax+b} sinx, e^{ax+b} cosx, (ax + b)^n sinx, (ax + b)^n cosx$, concavity and inflection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L' Hospitals rule, Application in business ,economics and life sciences.

UNIT-II

Riemann integration as a limit of sum, integration by parts, Reduction formulae, derivations and illustrations of reduction formulae of the type $\int sin^n xdx, \int cos^n xdx, \int tan^n xdx, \int sec^n xdx, \int (logx)^n dx, \int sin^n x cos^n xdx$,

definite integral, integration by substitution.

UNIT-III

Volumes by slicing, disks and washers methods, volumes by cylindrical shells, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution, techniques of sketching conics, reflection properties of conics, rotation of axes and second degree equations, classification into conics using the discriminant, polar equations of conics.

UNIT-IV

Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration.

LIST OF PRACTICALS

(To be performed using Computer with aid of MATLAB or such software)

1. Plotting the graphs of the functions $e^{ax+b}, log(ax + b), 1/ax + b, sin(ax + b), cos (ax + b)$ and $|ax + b|$ to illustrate the effect of a and b on the graph.

2. Plotting the graphs of the polynomial of degree 4 and5.

3. Sketching parametric curves (E.g. Trochoid, cycloid, hypocycloid).

4. Obtaining surface of revolution of curves.

5. Tracing of conics in Cartesian coordinates/polar coordinates.

6. Sketching ellipsoid, hyperboloid of one and two sheets (using Cartesian co-ordin
7. Find out the factorial of a number.   8. Check whether a number is prime or n
9. Sum of first natural numbers.   10. find $1^2 + 2^2 + ----$ 11. To generate Fibono
12. To print the numbers which are divisible by 2 or 5 between 1 and 100

BOOKS RECOMMENDED:

1. H.Anton, I.Bivensand S.Davis, *Calculus*,10thEd., JohnWileyand Sons(Asia) P

   Singapore, 2002.

2. Shanti Narayan, P. K. Mittal, Differential Calculus, S. Chand, 2014.

3. Shanti Narayan, P. K. Mittal, Integral Calculus, S. Chand, 2014.

BOOKS FOR REFERNCE:

1. James Stewart, Single Variable Calculus, Early Transcendentals, Cengage Learning, 201

2. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi,2005.

CORE PAPER-II

DISCRETE MATHEMATICS

Objective: This is a preliminary course for the basic courses in mathematics and a
applications. The objective is to acquaint students with basic counting principles, set theor
logic, matrix theory and graph theory.

Expected Outcomes: The acquired knowledge will help students in simple mathem
modeling. They can study advance courses in mathematical modeling, computer sci
statistics, physics, chemistry etc.

UNIT-I

Sets, relations, Equivalence relations, partial ordering, well ordering, axiom of choice, Zorn's lemma, Functions, cardinals and ordinals, countable and uncountable sets, statements, compound statements, proofs in Mathematics, Truth tables, Algebra of propositions, logical arguments, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, modular arithmetic, Chinese remainder theorem, Fermat's little theorem.

UNIT-II

Principles of Mathematical Induction, pigeonhole principle, principle of inclusion and exclusion Fundamental Theorem of Arithmetic, permutation combination circular permutations binomial and multinomial theorem, Recurrence relations, generating functions, generating function from recurrence relations.

UNIT-III

Matrices, algebra of matrices, determinants, fundamental properties, minors and cofactors, product of determinant, adjoint and inverse of a matrix, Rank and nullity of a matrix, Systems of linear equations, row reduction and echelon forms, solution sets of linear systems, applications of linear systems, Eigen values, Eigen vectors of amatrix.

UNIT-IV

Graph terminology, types of graphs, subgraphs, isomorphic graphs, Adjacency and incidence matrices, Paths, Cycles and connectivity, Eulerian and Hamiltonian paths, Planar graphs.

BOOKS RECOMMENDED:

1. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.

2. Kenneth Rosen Discrete mathematics and its applications Mc Graw Hill Education
   edition.
3. V Krishna Murthy, V. P. Mainra, J. L. Arora, An Introduction to Linear Algeb
   Affiliated East-West Press Pvt. Ltd.

BOOKS FOR REFERENCE:

1. J. L. Mott, A. Kendel and T.P. Baker: Discrete mathematics for Computer Scientists
   Mathematicians, Prentice Hall of India Pvt Ltd, 2008.

CORE PAPER-III

REAL ANALYSIS

Objective: The objective of the course isto have the knowledge on basic properties of the f
of real numbers, studying Bolzano-Weierstrass Theorem , sequences and convergence
sequences, series of real numbers and its convergence etc. This is one of the core cou
essential to start doing mathematics.

Expected Outcome: On successful completion of this course, students will be able
handle fundamental properties of the real numbers that lead to the formal development of
analysis and   understand limits and their use in sequences, series, differentiation
integration. Students will appreciate how abstract ideas and rigorous methods in mathemat
analysis can be applied to important practical problems.

UNIT-I

Review of Algebraic and Order Properties of R, ε-neighborhood of a point in R, Bounded ab
sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima,
Completeness Property of R, The Archimedean Property, Density of Rational (and Irratio
numbers in R., Intervals, Interior point, , Open Sets, Closed sets, , Limit points of a s
Illustrations of Bolzano-Weierstrass theorem for sets, closure, interior and boundary of a set

UNIT-II

Sequences and Subsequences, Bounded sequence, Convergent sequence, Limit of a seque

Limit Theorems, Monotone Sequences,. Divergence Criteria, Bolzano Weierstrass Theorem for Sequences, Cauchy sequence, Cauchy's Convergence Criterion. Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's nth root test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.

UNIT-III

Limitsof functions (epsilon-deltaapproach),sequential criterionforlimits, divergence criteria. Limit theorems, onesidedlimits, Infinitelimitsandlimits at infinity, Continuous functions, sequential criterion forcontinuity &discontinuity. Algebra ofcontinuousfunctions, Continuousfunctions onaninterval, Boundedness Theorem, Maximum Minimum Theorem, Bolzano's Intermediatevaluetheorem, location of rootstheorem, preservation of intervalstheorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem, Monotone and Inverse Functions.

UNIT-IV

Differentiabilityofafunction ata point&inaninterval, Caratheodory'stheorem, chain Rule,algebra of differentiable functions, Mean value theorem, interior extremum theorem. Rolle'stheorem, intermediate value property ofderivatives,Darboux'stheorem. Applications of mean value theorem toinequalities.

BOOKS RECOMMENDED:

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis(3rd Edition), John Wiley and Sons (Asia) Pvt. Ltd., Singapore,2002.
2. G. Das and S. Pattanayak, Fundamentals of Mathematical Analysis, TMH Publishing Co.

BOOKS FOR REFERENCE:

1. S.C. Mallik and S. Arora-Mathematical Analysis, New Age InternationalPublications.
2. A.Kumar, S. Kumaresan, *A basic course in Real Analysis*, CRC Press, 2014.
3. BrianS.*Thomson*,Andrew.M.*Bruckner*,andJudithB.*Bruckner*,*ElementaryReal Analysis*, Prentice Hall,2001.
4. Gerald G. Bilodeau, Paul R. Thie, G.E. Keough, *An Introductionto Analysis,*Jones & Bartlett, Second Edition, 2010.

CORE PAPER-IV

DIFFERENTIAL EQUATIONS

Objective: Differential Equations introduced by Leibnitz in 1676 models almost all Physi[cal], Biological, Chemical systems in nature. The objective of this course is to familiarize [the] students with various methods of solving differential equations and to have a qualita[tive] applications through models. The students have to solve problems to understand the method[s].

Expected Outcomes: A student completing the course is able to solve differential equati[ons] and is able to model problems in nature using Ordinary Differential Equations. This is [a] prerequisite for studying the course in Partial Differential Equations and models dealing [with] Partial Differential Equations.

UNIT-I

Differential equations and mathematical models, General, Particular, explicit, implicit [and] singular solutions of a differential equation. Exact differential equations and integra[ting] factors, separable equations and equations reducible to this form, linear equations [and] Bernoulli's equation, special integrating factors and transformations.

UNIT-II

Introduction to compartmental models, Exponential decay radioactivity (case study of detec[tion of] art forgeries), lake pollution model (with case study of Lake Burley Griffin), drug assimila[tion] into the blood (case study of dull, dizzy and dead), exponential growth of population, De[nsity] dependent growth, Limited growth with harvesting.

UNIT-III

General solution of homogeneous equation of second order, principle of superposi[tion for a] Wronskian, its properties and applications, method of undetermined coefficients, Metho[d of] variation of parameters, Linear homogeneous and non-homogeneous equations of higher o[rder] with constant coefficients, Euler's equation.

UNIT-IV

Equilibrium points, Interpretation of the phase plane, predatory-pray model and its analysis, epidemic model of influenza and its analysis, battle model and its analysis.

Practical / Lab work to be performed on a computer:

Modeling of the following problems using *Matlab / Mathematica / Maple* etc.

1. Plotting of second & third order solution family of differentialequations.

2. Growth & Decay model (exponential caseonly).

3. (a) Lake pollution model (with constant/seasonal flow and pollution concentration)/

   (b) Case of single cold pill and a course of cold pills.

   (c) Limited growth of population (with and without harvesting).

4. (a) Predatory-prey model (basic volterra model, with density dependence, effect of DDT, two prey one predator).

   (b) Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers).

   (c) Battle model (basic battle model, jungle warfare, long range weapons).

5. Plotting of recursivesequences. 6. Print all the odd numbers between 1 and 100. 7. To find $x + \frac{x^2}{2!}$ 8. Sum of first n odd natural numbers. 9. Sum of first n even natural numbers. 10. To print all Armstrong numbers between 1 to 500. 11. Print all the leap years bet" 1900 (both years included

BOOKS RECOMMENDED:

1. J. Sinha Roy and S Padhy: A course of Ordinary and Partial differential equation Kalyani Publishers,New Delhi.

2. Belinda Barnes and Glenn R. Fulford, *Mathematical Modeling with Case Studies,A DifferentialEquationApproachusingMapleandMatlab,*2ndEd.,TaylorandFrancisgroup, London and New York,2009.

BOOKS FOR REFERENCE:

1. Simmons G F, Differential equation, Tata Mc GrawHill, 1991.

2. Martin Braun, Differential Equations and their Applications, Springer International, Student

CALCULUS AND DIFFERENTIAL EQUATIONS

Objective: Calculus invented by Newton and Leibnitz is a powerful analytical tool to solve mathematical problems which arise in all branches of science and engineering. The main emphasis of this course is to equip the student with necessary analytic and technical skills to handle problems of a mathematical nature as well as practical problems using calculus and differential equation. The aim should be to expose the students to basic ideas quickly without much theoretical emphasis with importance on applications.

Excepted Outcomes: After completing the course, students are expected to be able to apply knowledge of calculus and differential equations in the areas of their own interest.

UNIT-I

Curvature, Asymptotes, Tracing of Curves (Catenary, Cycloid, Folium of Descartes), Rectification, Quadrature, Elementary ideas about Sphere, Cones, Cylinders and Conicoids.

UNIT-II

Reviewoflimits,continuityanddifferentiabilityoffunctionsofonevariable and their properties, Rolle's theorem, Mean value theorems, Taylor's theorem with Lagrange's theorem and Cauchy's form of remainder, Taylor's series, Maclaurin's series of $sinx, cosx, e^x, \log(1+x), (1+x)^m$, L' Hospital's Rule, other Intermediate forms.

UNIT-III

Limitand Continuity of functions of several variables, Partial derivatives, Partial derivatives of higher orders, Homogeneous functions, Change of variables, Mean value theorem,Taylors theorem and Maclaurin's theorem for functions of two variables (statements &applications), Maxima and Minima of functions of two and three variables, Implicit functions, Lagrange's multipliers (Formulae & its applications), Concepts of Multiple integrals & its applications.

Prayact
24.07.19

24.7.19

UNIT-IV

Ordinary Differential Equations of order one and degree one (variables separable, homogeneous, exact and linear). Equations of order one but higher degree. Second order linear equations with constant coefficients, homogeneous forms, Second order equations with variable coefficients, Variation of parameters.

BOOKS RECOMMENDED:

1. Shanti Narayan, P. K. Mittal, Differential Calculus, S. Chand, 2014.

2. Shanti Narayan, P. K. Mittal, Integral Calculus, S. Chand, 2014.

3. S.C. Mallik and S. Arora-Mathematical Analysis, New Age InternationalPublications.

4. J. Sinharoy and S. Padhy: A Course of Ordinary and Partial Differential Equations, Kalyani Publishers.

BOOK FOR REFERENCES:

1. H.Anton,I.Bivensand S.Davis,*Calculus*,10thEd.,JohnWileyand Sons(Asia)P.Ltd.,Singapore, 2002.

2. Shanti Narayan and P.K. Mittal-Analytical Solid Geometry, S. Chand & Company Pvt. Ltd., New Delhi.

3. Martin Braun-Differential Equations and their Applications-Martin Braun, Springer International.

4. B. P.AcharyaandD. C.Sahu:AnalyticalGeometryofQuadraticSurfaces,KalyaniPublishers.

Sem - IV

Generic Elective Paper II

ALGEBRA

Objective: This is a preliminary course for the basic courses in mathematics like, abstract algebra and linear algebra. The objective is to acquaint students with the properties of natural numbers i.e. Euclidean algorithm, congruence relation, fundamental theorem of arithmetic, etc. The basics of linear algebra i.e. vector spaces, matrices are introduced here.

Expected Outcomes: Theacquired knowledge will help students to study further courses in mathematics like, group theory, ring theory and field theory and linear algebra. It has applications not only in higher mathematics but also in other science subjects like computer science, statistics, physics, chemistry etc.

UNIT-I

Sets, relations,Equivalence relations, partial ordering, well ordering, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, statements, compound statements, proofs in Mathematics,Truth tables, Algebra of propositions, logical arguments

UNIT-I

Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.

UNIT-III

Matrices, algebra of matrices, determinants, fundamental properties, minors and cofactors, product of determinant, adjoint and inverse of a matrix, Rank and nullity of a matrix, Systems of linear equations, row reduction and echelon forms, solution sets of linear systems, applications of linear systems,.

UNIT-IV

Vector spaces and subspaces, examples, linear independence, linear dependence, basis, dimension, examples, Introduction to linear transformations, matrix representation of a linear transformation, Eigen values, Eigen vectors of amatrix.

BOOKS RECOMMENDED:

1.Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory,

3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.

2.V Krishna Murthy, V P Mainra, J L Arora, An Introduction to Linear Algebra , Affiliated East-West Press Pvt. Ltd

BOOKS FOR REFERENCE:

1.   DavidC.Lay,LinearAlgebraanditsApplications,3rdEd.,PearsonEducationAsia,Indian Reprint,2007.

2. B S Vatsa and Suchi Vatsa Theory of Matrices New age International third edition 2010.

3. Ward Cheney, David kincaid. Linear algebra theory and applications, Jones and Bartlett ,2010.

OR

GENERIC ELECTIVES (FOR FOUR PAPERS CHOICE)

Generic Elective Paper III