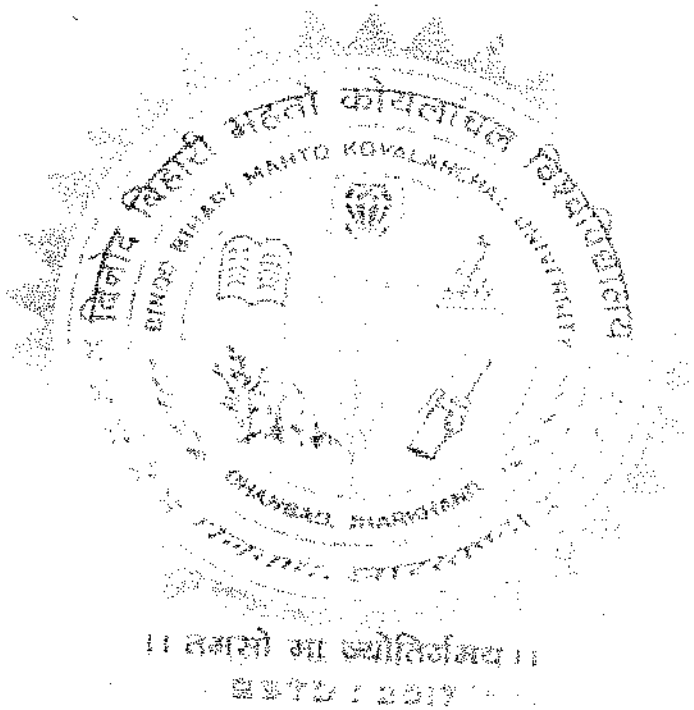
SYLLABUS FOR

THE FOUR –YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS (MAJOR,MINOR) AND MULTIDISCIPLINARY COURSE (MDC)

As Per Provision of NEP -2020 to be implemented from academic year -2023 onwards.



for

All Constituent / Affiliated Colleges Under

Binod Bihari Mahto Koyalanchal University,

Dhanbad (Jharkhand).

BINOD BIHARI MAHTO KOYALANCHAL UNIVERSITY
Dhanbad, Jharkhand - 826004
E-mail:- registrarbbmku@gmail.com

Notification

In exercise of the powers vested in him under the Jharkhand State Universities Act 2000 as amended up-to-date, the Vice-Chancellor is pleased to constitute a Board of Studies (BOS) for the Department of Mathematics at Under Graduate Level, comprising of following members for a period of one year from the date of notification :

1. Dr. R.K. Tiwari
   Head, University Department of Mathematics,
   BBMKU - Chairman
2. Dr. Shiv Prasad
   University Department of Mathematics, BBMKU. -Member
3. Dr. D.N. Singh
   Head, Department of Mathematics
   Chas College, Chas. -Member
4. Dr. Nasim Ahmad (Retd.)
   Ex- Head, Department of Mathematics,
   P.K. Roy Memorial College, Dhanbad. - Special Invitee
5. Dr. T.P. Choubey (Retd.),
   Ex- Head, Department of Mathematics,
   Chas College, Chas. -Special Invitee

By order of the Vice-Chancellor
Sd/-
Registrar

Memo No. BBMKU/R/1229/2022 Date 14/07/2023

Copy to: -

1. Persons concerned.
2. Dean, Faculty of Science, BBMKU.
3. Head, University Department of Mathematics.
4. Establishment Section, BBMKU, Dhanbad.
5. P.A. to VC/PVC/R for information to VC/PVC/R.
6. Guard File.

Registrar
BBMKU, Dhanbad.

Local Disk D/Madan Gopal/Esstt./BOS/BBMKU/2022/ 28

CONTENTS

COURSE OF STUDY FOR FOUR YEAR UNDERGRADUATE PROGRAMME 2023 ON

Semester wise Course code and Credit Points for Single Major

Semester	Common , Introductory, Major, Minor, Vocational & Internship Courses		
	Code	Papers	
I	AEC-1	Language and Communication Skills (MIL-1: Modern Indian language including TRL)	
	VAC-1	Value Added Course -1	
	SEC-1	Skill Enhancement Course -1	
	MDC-1	Multi- disciplinary Course-1	
	MN-1A	Minor from Discipline-1	
	MJ-1	Major Paper 1 (disciplinary Interdisciplinary Major)	
II	AEC-2	Language and Communication Skills (English)	
	SEC-2	Skill Enhancement Course -2	
	MDC-2	Multi-Disciplinary Course-2	
	MN-2A	Minor from Vocational Studies /Discipline-2	
	MJ-2	Major Paper 2 (Disciplinary/Interdisciplinary Major)	
	MJ-3	Major paper 3 (Disciplinary/Interdisciplinary Major)	
III	AEC-3	Language and Communication Skills (MIL-2,Modern Indian language including TRL)	
	SEC-3	Skill Enhancement Course -3	
	MDC-3	Multi-Disciplinary Course-3	
	MN-1B	Minor for Discipline-1	
	MJ-4	Major Paper 4 (Disciplinary/Interdisciplinary Major)	
	MJ-5	Major paper 5 (Disciplinary/Interdisciplinary Major)	

IV	AEC-3	Language and Communication Skills (MIL-2/ English-2)
	VAC-2	Value Added Course -2
	MN-2B	Minor from Vocational Studies Discipline-2
	MJ-6	Major paper 6(Disciplinary /Interdisciplinary Major)
	MJ-7	Major paper 7(Disciplinary /Interdisciplinary Major)
	MJ-8	Major Paper 8 (disciplinary Interdisciplinary Major)
V	MN IC	Minor fom Discipline-1
	MJ-9	Major Paper 9 (Disciplinary/Interdisciplin... Major)
	MJ-10	Major paper 10 (Disciplinary/Interdisciplinary Major)
	MJ-11	Major paper 11 (Disciplinary/interdisciplinary Major)
	IAP	Internship / Apprenticeship/field Work / Dissertation/ Project.
VI	MN-2C	Minor from Vocational Studies/ Discipline-2
	MJ-12	Major Paper 12 (Disciplinary/Interdisciplinary Major)
	MJ-13	Major paper 13 (Disciplinary/Interdisciplinary Major)
	MJ-14	Major paper 14 (Disciplinary/interdisciplinary Major)
	MJ-15	Major paper 15 (Disciplinary/Interdisciplinary Major)

VII		MN-1D	Minor from Discipline-1
		MJ-16	Major Paper 16 (Disciplinary/Interdisciplinary Major)
		MJ-17	Major paper 17 (Disciplinary/Interdisciplinary Major)
		MJ-18	Major paper 18 (Disciplinary/Interdisciplinary Major)
		MJ-19	Major paper 19 (Disciplinary/Interdisciplinary Major)
VIII		MN-2D	Minor from vocational studies / Discipline-2
		MJ-20	Major Paper 20 (Disciplinary/Interdisciplinary Major)
		RC/	Research Internship / Field Work /Dissertation
			or
		AMJ 1	Advanced Major Paper-1(Disciplinay/ Interdisciplinary Major)
		AM J2	Advanced Major Paper-2(Disciplinay/ Interdisciplinary Major)
		AMJ3	Advanced Major Paper-3(Disciplinay/ Interdisciplinary Maor)
			Total Credit

NUMBER OF CREDITS BY TYPE OF COURSE

The hallmark of the new curriculum framework is the flexibility for students to learn courses of their choice across various disciplines in undergraduate programmes. This requires that all departments provide a certain specified number credits for each course and its instruction hours (slot time).

Overall Course Credit Points for Single Major

Courses	Nature of Courses	3yr UG Credits
Major	Core courses	60
Minor	i. Discipline/Interdisciplinary couses and ii. Vocational Cousus	24
Multidisciplinary	3 courses	9
AEC	Language course	8
SEC	Courses to be developed by the University	9
Value Added Course	Understanding India, Environmental Studies, Digital Education, Health & wellness , summer Internship/ Apprenticeship/ Community outreach activities, etc.	6
Internship(In any stummer vacation for Exit points or In Semester –V)		4
Research /Dissertation/ Advance Major Courses	Research Institutions/3 courses	12
	Total Credits	120

Overall Course Code and Additional Credit Points for Hons...

Courses	Nature of Courses	3yr UG Credit
Major-1	Core courses	60
Major-2	Core Courses	48
Minor	i. Discipline/Interdisciplinary couses and ii. Vocational Couses	24
Multidisciplinary	3 courses	9
AEC	Language course	8
SEC	Courses to be developed by the University	9
Value Added Course	Understanding India, Environmental Studies, Digital Education, Health & wellness , summer Internship Apprenticeship/Community outreach activities, etc.	6
Internship(In any summer vacation for Exit points or in Semester –V)		4
Research /Dissertation/ Advance Major Courses	Research Institutions/3 courses	12
	Total Credits	168

Semester wise Course Code and Additional Credit Points

Semester	Common , Introductory, Major, Minor, Vocational & Interdisciplinary Courses	
	Code	Papers
I	DMJ-1	Double Major Paper -1(Disciplinary /Interdisciplinary Major)
	DMJ-2	Double Major Paper -2(Disciplinary /Interdisciplinary Major)
II	DMJ-3	Double Major Paper -3(Disciplinary /Interdisciplinary Major)
	DMJ-4	Double Major Paper -4 (Disciplinary /Interdisciplinary Major)
III	DMJ-5	Double Major Paper -5 (Disciplinary /Interdisciplinary Major)
	DMJ-6	Double Major Paper -6 (Disciplinary /Interdisciplinary Major)
IV	DMJ-7	Double Major Paper -7 (Disciplinary /Interdisciplinary Major)
	DMJ-8	Double Major Paper -8 (Disciplinary /Interdisciplinary Major)
V	DMJ-9	Double Major Paper -9 (Disciplinary /Interdisciplinary Major)
	DMJ-10	Double Major Paper -10 (Disciplinary /Interdisciplinary Major)
VI	DMJ-11	Double Major Paper -11 (Disciplinary /Interdisciplinary Major)
	DMJ-12	Double Major Paper -12 (Disciplinary /Interdisciplinary Major)

VII	DMJ-13	Double Major Paper plinary Major)	13 (Disciplinary /Inter
	DMJ-14	Double Major Paper plinary Major)	14 (Disciplinary /Inter
VIII	DMJ-15	Double Major Paper plinary Major)	15 (Disciplinary /Inter
			Total Credit

Abbreviations:-

AEC	Ability Enhancement Courses
SEC	Skill Enhancement Courses
IAP	Internship /Apprenticeship /Project
MDC	Multidisciplinary Courses
MJ	Major Disciplinay/ Interdisciplinary Courses
DMJ	Double Major Disciplinary/Interdisciplinary Courses
MN	Minor Disciplinary/Interdisciplinary Courses
AMJ	Advance Major Disciplinay/Interdisciplinary Courses
RC	Research Courses

Marks Distribution for Examination for 3 Yr. Major and ... Programme of 160 Credits .

1) There will be only one Semester Internal Examination for ... Minor.

2) 25 Marks in theory Examination may include 20 Marks from written Examination on/ Assignment / Project ... Wherever applicable whereas 5 marks will be awarded ... attendance / overall class performance in the semester.

3) To convert attendance into marks a suggestive range ... here. However, institutions may develop its own ... [Attendance: upto 45% -1 Mark; 45 <Attd. < 55 ... 55<Attd. <65 -3 Marks ; 65 <Attd <75-4 Marks, 75 < Att...

4) Guidelines for Question Setter:

i) Question paper shall show full Marks (FM), Pass Marks ... anid Maximum Time allowed (in Hrs.) of the top of the Question paper

ii) There will be two categories of Questions Namely Group –A, Group –B.

Gropup –A will be of very short answer type of (combination objective type excluding multiple choice questions) ... & Short answer type of 5 marks and questions in sub part will be all compulsory .

Group –B will contain long answer type questions

iii) For Semester Internal Examination (SIE 25 ... 1 Hr. Exam):

There will be two group of questions.

Group A is compulsory which will contain two qu...

Question No. 1 will be very short answer type con... five questions of 1 mark each.

Qustion No. -2 will be short answer type consist... question of 5 marks.

Group –B will contain descriptive type two qu... ten(10) marks each out of which any one to answe...

iv) For End Semester Examination (ESE-75 Marks, ... Exam.)

There will be two group of questions.

Group A is Compulsory which will contain three (03) questions Question No. -1 will be very short answer ty... consisting of five (05) questions of 1 mark each Questi... No. 2 and 3 will be short answer type of 5 marks.

Group –B will contain descriptive type Six (6). Questi... fifteen marks each, out of which any four are to be ...

Marks distribution pattern. [25 marks for each credit]

Subjects	Credits	F.M.	Semester Internal Examination	End Semester Examination
Ability Enhancement Courses	2	50	---	
Value Added Courses	2	50	---	
Skill Enhancement Courses	3	75	---	
Multidisciplinary Courses	3	75	---	
Minor Courses	4	100	25	
Advanced Major	4	100	25	
Research Courses i. Reseach Methodology (FM.=100) ii. Synopsis, Thesis & others(F.M.=200)	12	100+ 200	25+, ...	
Vocational Courses Including Internship	4	100	--	100/(Grade point awarded by the concerned org...
Non-Practical Subjects (MJ/MN)	4	100	25	
Practical subjects(MJ/MN)	4	[illegible]	[illegible]	[illegible]
		75	15	60

Pass Marks in 160 Credit Course [40% of F.M.]

i. The pass marks in 160 Credit courses will be 40% of the marks obtained in each Course opted by the student.

ii. To Pass in MIL / Non-Hindi subject a student must obtain minimum 20 marks out of 50 marks in 2 credit courses.

Full Marks (FM) & Pass Marks (PM) Pattern for Subject

Subjects	F.M.
MIL Hindi	50
Other Language	50
Non- Practical Subjects	100
Non- Practical Subjects	75
Non Practical Subjects:	50
Practical Subjects: Theory Paper	75
Pratical Subjects : Paractical Paper	25
Practical Subjcts: Practical Paper	50
Practical Subjects: Practical Paper	75
Practical Subjects: Practical Paper	100

CHOOSING PROGRAMME/ STUDY [illegible] IN THE [illegible]

UNDERGRADUATE PROGRAMME [illegible]

2024 [illegible]

Option to select subject combination from [illegible] programmes.

NATURAL AND PHYSICAL SCIENCE

S.NO.	Major	Minor
'01	Botany	Chemistry
		Geology
		Zoology
		Economics
		Geography

S.NO.	Major	Minor
'02	Chemistry	Botony
		Mathematics
		Physics
		Zeology
		Economics

S.NO.	Major	Minor
`03	Physics	Chemistry
		Statistics
		Mathmatics
		Economics
		Geography
		Philosophy

S.NO.	Major	Minor
`04	Geology	Botany
		Chemistry
		Mathmatics
		Physics
		Zoology
		Anthropology
		Economics
		Geography

MATHEMATICS , STATISTICS AND COMPUTER APPLICATIONS

S.NO.	Major	Minor
1	Mathematics	Chemistry
		Physics
		Geology
		Statistics
		Economics
		Commerce
		Cyber Defense

S.NO.	Major	Minor
2	Statistics	Mathematics
		Economics
		Geography
		History
		Product Science
		Commerce

LIBRARY, INFORMATION AND MEDIA STUDIES

S.NO.	Major	Minor
1	Cyber Defense	Mathematics Statistics

COMMERCE AND MANAGEMENT

S.NO.	Major	Minor
1	COMMERCE	Mathematics Statistics Anthropology Economics Geography History Home Science Political Science Psychology Sociology Philosophy

MAJOR COURSE-[illegible]

Credits -04 (60 Hs.), (Credits: [illegible] Tutorial: 01)

Full Marks: 25(SIE:1 Hs) +75(ESE:3Hrs)=100 Pass Marks(SIE:10+ESE:[illegible])

Instruction to Question Setter for:

Semester Internal Examination (SIE):

There will be two group of questions. Group A is compulsory and contains two questions in which question no. 1 contains five questions of very short type consisting of 1 mark each, and question No. 2 is a question of short answer type 5 marks. Group B will contain six questions type two questions of 10 marks each, out of which any one is to be answered.

End Semester Examination (ESE):

There will two group of questions. Group A is compulsory and contain three questions. Question No. 1 will be very short answer type consisting of five questions of 1 mark each. Question No. 2 and 3 are short answer type consisting two questions of 5 marks. Group B contain descriptive type six questions of fifteen marks each, of which any four are to be answer.

Note: There may be subdivisions in each question asked in the Semester Examinations

DIFFERENTIAL CALCULUS , INTEGRAL CALCULUS, ...
GEMOETRY 2D & VECTOR CALCULUS:

UNIT-I

Successive Differentiation, Expansion, Indeterminate forms, Asymptotes

UNIT-II

Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x dx$, $\int \cos^n x dx$, $\int \tan^n x dx$, $\int \sin^n x \cos^n x dx$, $\int \sin nx dx$, $\int \cos nx dx$, $\int (\log x)^n dx$, paramentric equations, parameterizing a curve, arc length, arc length of poarametric curves , volume and area of surface of revolution.

UNIT-III

General equation of the second degree, General conic, polar equation of conics.

UNIT-IV

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

Books Recommended

1. G.B. Thomas and R.L. Finney, Calculus , 9th Ed., Pearson Education, 2005.
2. M.J. Strauss, G.L. Bradley and K.J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India)P. Ltd. (Pearson Education), Delhi, 2007
3. H.Anton, I. Bivens and S.Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P.Ltd., Singapore, 2002.
4. R. Courant and F.John, Introduction to Calculus and Analysis (Volume I), Springer Velag, New York,Inc., 1989

SEMESTER – II

MAJOR COURSE-[illegible]

Credits -04 (60 Hs.), (Credits: Lecture-03 Tutorial-01)

Full Marks: 25(SIE:1 Hs) +75(ESE:3Hrs)=100 Pass Marks(SIE:10+ESE:30)=[illegible]

Instruction to Question Setter for :

Semester Internal Examination (SIE):

There will be two group of questions. Group A is compulsory and contains two questions in which question No. 1 contains five questions of very short type consisting of 1 mark each, and question No. 2 contains one question of short answer type 5 maks. Group B will contain descriptive type two questions of 10 marks each, out of which any one is to answer.

End Semester Examination (ESE):

There will two group of questions. Group A is compulsory and contain three questions. Question no. 1 will be very short type consisting of five questions of 1 mark each. Question No. 2 and 3 will be short answer type consisting two questions of 5 maks. Group B will contain descriptive type six questions of fifteen marks each, out of which any four are to be answer.

Note: *There may be subdivisions in each question asked in End Semester Examinations.*

REAL ANALYSIS-I

UNIT-I

Idea of countable sets, uncountable sets and uncontability of R. Bou... above sets, bounded below sets, Bounded sets, Unbounded ... Suprema and Infima, Intervals, limits points of a set, Isolated ... Illustration of Bolzano- Weierstrass theorem for sets.

10 Lectures(1 Qu...

UNIT-II

Sequences, Bounded sequences, Convergent sequence, Limit ... sequence. Limits theorems, Monotone sequences, Monotone Conver... theorem, Subsequences, Divergence Criteria, Monotone Subsequen... theorem (statement only), Bolzano- Weierstrass Theorem for Sequen... Cauchy sequences, Cauchey's Convergence Criterion.

20 Lectures(2 Questio...

UNIT-III

Infinite series, convergence and divergence of infinite series, Cau... Criterion, Test for convergence: Comparison test, Limit Comparison ... Ratio Test, Cauchy's nth root test, Kabbe's test, De-Morgan's ... Bertrand's test, Alternative series, Leibnitz test, Absolute and Conditio... convergence, Kummer's test, logarithmic test.

30 Lectures(3 Questio...

Books Recommended

1. R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis, 3rd Ed., J... Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. Gerald G. Bilodeau, Paul R. Thie, G.E. Keough, An Introduction to Analysis ... Ed., Jones & Bartlett, 2010.
3. Brain S. Thmson, Andrew. M. Bruckner and Judith B. Bruckner, El... Real Analysis, Prentice Hall, 2001.
4. S.K. Berberian , A First Course in in Real Analysis , Springer Verlag, ... York , 1994.
5. , New York,Inc., 1989

MAJOR COURSE – Adj-3

Credits -04 (60 Hs.), (Credits: Lecture-03 Tutorial-01)

Full Marks: 25(SIE:1 Hs) +75(ESE:3Hrs)=100 Pass Marks(SIE:10+ESE:30)=40

Instruction to Question Setter for :

Semester Internal Examination (SIE):

There will be two group of questions. Group A is compulsory and contains two questions in which question No. 1 contains five questions of very short type consisting of 1 mark each , and question No. 2 is a question of short answer type 5 maks. Group B will contain descriptive type two questions of 10 marks each, out of which any one is to answer.

End Semester Examination (ESE):

There will two group of questions. Group A is compulsory and will contain three questions. Question No. 1 will be very short answer type consisting of five questions of 1 mark each Question No. 2 and 3 will be short answer type consisting two questions of 5 maks. Group B will contain descriptive type six questions of fifteen marks each, out of which any four are to be answer.

Note: There may be subdivisions in each question asked in End Semester Examinations.

HIGHER ALGEBRA & TRIGONOMETRY

UNIT-I

Polar representation of complex numbers, nth rots of unity , De Moivr... theorem for rational indices and its applications, logarithmic of comp... numbers.

20 Lectures(2 Quest...

UNIT-II

System of linear equations, row reduction and echelon forms, v... equations, the matrix equation Ax=b , solution set of liner syst... applications of linear systems, linear independence.

20 Lectures(2 Quest...

UNIT-III

Introduction to linear transformations, matrix of a linear transform... inverse of a matrix, characterizations of invertible matrices. Subspace... R^n,dimension of subspaces of R^n,and rank of a matrix, Eigen val... Eigen Vectors and Characteristic Equation of a matrix.

20 Lectures(2 Quest...

Books Recommended

1. Titu Andreescu and Dorin Andrica, Complex Number from A to ... Birkhauser, 2006.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathemati... with Graph Theory, 3d Ed., Pearson Education (Singapore)P... Indian Reprint, 2005.
3. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pear... Eucation Asia, Indian Reprint, 2007.

SEMESTER –III

MAJOR COURSE-MJ-4

Credits -04 (60 Hs.), (Credits: Lecture-03 Tutorial-01) Full Marks:
25(SIE:1 Hs) +75(ESE:3Hrs)=100 Pass Marks(SIE:10+ESE:30)=40

Instruction to Question Setter for :

Semester Internal Examination (SIE):

*There will be **two** group of questions. **Group A is compulsory** and will contains two questions in which question No. 1 contains five questions of **very short type** consisting of 1 mark each , and question No. 2 have one question of short answer type 5 maks . **Group B will contain descriptive type** two questions of 10 marks each, out of which any one is to answer.*

End Semester Examination (ESE):

*There will **two** group of questions. **Group A is compulsory** and will contain three questions. **Question No. 1 will be very short answer type** consisting of five questions of 1 mark each **Question No. 2 and 3 will be short answer type** consisting two questions of 5 maks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to be answer.*

***Note:** There may be subdivisions in each question asked in End Semester Examinations.*

DIFFERENTIAL EQUATION::

UNIT-I

Differential equations and mathematical models. General, particular, explicit , implicit and singular solutions of a differential equation. Exact differential equations and integrating factos, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations.

20 Lectures(2 Questions)

UNIT-II

General solution of linear homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: Its properties and applications , Linear homogeneous and Non- homogeneous equations of higher oder with constant coefficients, Euler's equation, method of undetermined coefficients, method of various of parameters.

20 Lectures(2 Questions)

UNIT-III

Bessel's equation an Legender's equation, recurrence formulae, orthogonal properties, generating function, Laplace transform and inverse transform, properties, application to initial value problem upto Second order ODE

20 Lectures(2 Questions)

Books Recommended

1. *Belinda Barnes and Glenn R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab , 2nd Ed., Taylor and Francis group. London and New Y oprk, 2009.*
2. *C.H. Edwards and D.E. Penny, Differential Equations and Boundary Value problems computing and Modeling.,m Pearson Education India, 2005*
3. *S.L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India, 2004*
4. *Martha L Abell, James P BAselton, Differential Equations with MATHEMATICA, 3d Ed., Elsevier Academic Press , 2004*

MAJOR COURSE-MJ-5

Credits -04 (60 Hs.), (Credits: Lecture-03 Tutorial-01)

Full Marks: 25(SIE:1 Hs) +75(ESE:3Hrs)=100 Pass Marks(SIE:10+ESE:30)=40

Instruction to Question Setter for :

Semester Internal Examination (SIE):

*There will be **two** group of questions. **Group A is compulsory** and will contains two questions in which question No. 1 contains five questions of **very short type** consisting of 1 mark each , and question No. 2 have one question of short answer type 5 maks . **Group B will contain descriptive type** two questions of 10 marks each, out of which any one is to answer.*

End Semester Examination (ESE):

*There will **two** group of questions.. **Group A is compulsory** and will contain three questions. **Question No. 1 will be very short answer type** consisting of five questions of 1 mark each **Question No. 2 and 3 will be short answer type** consisting two questions of 5 maks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to be answer.*

***Note:** There may be subdivisions in each question asked in End Semester Examinations.*

THEORY OF REAL FUNCTIONS:

UNIT-I

Limits of functions ($\varepsilon - \delta$ approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity, Continuous functions, sequential criterion for continuity and discontinuity. Algebra of continuous functions. Continuous functions on an interval , intermediate value theorem, location of roots theorem Uniform continuity , non-uniform continuity criteria, uniform continuity theorem.

20 Lectures(2 Questions)

UNIT-II

Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. Relative extrema, interior extremum theorem. Rolle's Theorem, Mean value theorem, intermediate value property of derivatives, Darboux's theorem. Applications of mean value theorem to inequalities and approximation of polynomials, Talyor's theorem to inequalities. .

20 Lectures(2 Questions)

UNIT-III

Cauchy's mean value theorem. Taylor's therem with Largange's form of remainder, Taylor's theorem with Cauchy's form of remainder, Application of Taylor's theorem to convex functions, relative extrema. Taylor's series and Maclaurin's series expansion of exponential and trigonometric function , 1n(1+ x), 1/ax+b and (1+x)"

20 Lectures(2 Questions)

Books Recommended

1. R. Bartle and D.R. Sherbert, Introduction to Real Analysis , John Wiley and Sons, 2003.
2. K.A. Ross, Elementary Analysis: The Theory of Calculus, Springr , 2004.
3. A Mattuck, Introduction to Analysis, Prentice Hall, 1999.
4. S.R. Ghorpade and B.V. Limaye, A Course in Calculus and Real Analysis, Pringer, 2006.

SEMESTER –IV

MAJOR COURSE – MJ-6

Credits-04 (60 Hrs.), (Credits Lecture -03 Tutorial -01)
Full Makrs : 25(SIE: 1 Hrs) + 75(ESE: 3Hrs)=100 Pass Marks (SIE:10+ESE:30=40

Semester Internal Examination (SIE):

There will be to group of questions Group **A is compulsory** and will contain two questions in which question No. 1 contains five questions of **very short** type consisting of 1 mark each, and question No. 2 have one question of short answer type 5 marks. **Group B will contain descriptive type two questions** of 10 marks each, out of which any one is to answer.

End Semester Examination (ESE):

There will two group of questions. Group A is compulsory and will contain three questions. Question No.-1 will be very short answer type consisting of five questions of 1 mark each question No. 2 and 3 will be short answer type consisting two questions of 5 marks. Group B will contain descriptive type six questions of fifteen marks each, out of which any four are to be answer .

Note: There may be subdivisions in each question asked in End Semester Examinations.

Group theory I :

UNIT- I

Definition and examples of groups including elementary properties of groups. Subgroups and examples and theorems on subgroups, normal subgroup, centralizer, normalizer, center of a group .

20 Lectures (2 questions)

UNIT-II

Properties of cyclic groups, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group. Properties of cosets, Lagrange's theorem and consequences including . Fermat's Little theorem.

15 Lectures (2 questions)

UNIT III

Factor groups, Cauchy's theorem for finite abelian groups . Group homomorphsms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First , Second and Third Isomorphism theorems.

25 Lectures (2 questions)

Books Recommended

1. John B. Fraleigh, A First Course in Abstract Algebra , 7th , Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011
3. Joseph A , Gallian, Contemporary Abstract Algebra , 4th Ed., Narosa Publishing House, New Delhi, 1999.
4. Joseph J. Rotman, An introduction to the Theory of Groups,4th Ed., Springer Verlag, 1995
5. I.N.Herstein, Topics in Algebra, Wily Eastrn Limited , India,1975

MAJOR COURSE – MJ-7

Credits-04 (60 Hrs.), (Credits Lecture -03 Tutorial -01)
Full Makrs : 25(SIE: 1 Hrs) + 75(ESE: 3Hrs)=100 Pass Marks (SIE:10+ESE:30=40

Semester Internal Examination (SIE):

There will be to group of questions Group **A is compulsory** and will contain two questions in which question No. 1 contains five questions of **very short** type consisting of 1 mark each, and question No. 2 have one question of short answer type 5 marks. **Group B will contain descriptive type two questions** of 10 marks each, out of which any one is to answer.

End Semester Examination (ESE):

There will two group of questions. Group A is compulsory and will contain three questions. Question No.-1 will be very short answer type consisting of five questions of 1 mark each question .No. 2 and 3 will be short answer type consisting two questions of 5 marks. Group B will contain descriptive type six questions of fifteen marks each, out of which any four are to be answer .

Note: There may be subdivisions in each question asked in End Semester Examinations.

PARTIAL DIFFERENTIAL EQATION AND SYSTEMS OF ORDINARY DIFFERENTIAL EQUATION.:

UNIT- I

Partial Differential Equations – Basic concepts and Definitions, Mathematical Problems, first Order Equations: Classification, Construction and Geometrrical Interpretation. Method of Characteristics for obtaining General Solution of Quasi Linear Equations . Canonical Forms of first-order Linear Equations. Largrange's equation, Method of Separation of Variables for solving first order partial differential equations.

20 Lectures (2 questinos)

UNIT II

Introduction of Heat equation, Wave equation and Laplace equation. Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order Linear Equations to canonical forms.

20 Lectures (2 questinos)

UNIT III

Nonlinear partial differential equation , standard forms I, II, III and IV, Charpit's method, Monge's method to solve quation of the forms (i) Rr+ Ss+Tt=V and (ii) Rr+ Ss + Tt + U(rt = s^2) = V

20 Lectures (2 questinos)

Books Recommended

1.Tyn Myint-U and Lokenath Debnath, Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Springer, Indian reprint, 2006

2.S.L. Ross, Differential equations, 3rd Ed., John Wiley and Sons, India, 2004

3.Martha L Abell, James P Braselton, differential equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.

MAJOR COURSE – MJ-8

Credits-04 (60 Hs.), (Credits Lecture -03 Tutorial -01)
Full Makrs : 25(SIE: 1 Hs) + 75(ESE: 3Hrs)=100 Pass Marks (SIE:10+ESE:39=40

Semester Internal Examination (SIE):

There will be to group of questions Group **A is compulsory** and will contains two questions in which question No. 1 contains five questions of **very short** type consisting of 1 mark each, and question No. 2 have one question of short answer type 5 marks. **Group B will contain descriptive type two questions** of 10 marks each, out of which any one is to answer.

End Semester Examination (ESE):

There will two group of questions. Group A is compulsory and will contain three questions. Question No. 1 will be very short answer type consisting of five questions of 1 mark each question No. 2 and 3 will be short answer type consisting two questions of 5 marks. Group B will contain descriptive type six questions of fifteen marks each, out of which any four are to be answer .

Note: There may be subdivisions in each question asked in End Semester Examinations.

NUMERICAL METHODS :

UNIT I

Algorithms, Convergence, Errors: Relative, Absolute. Transcendental and Polynomial equations: Bisection method, Newton's Method.

16 Lectures (1 question)

UNIT II

System of linear algebraic equations : Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi Method.

Interpolation : Lagrange and Newton's methods. Error bounds. Finite difference operators. Newton's Gregory forward and backward difference interpolation.

24 Lectures (2 questions)

UNIT III

Numerical differentiation, Numerical Integration: Trapezoidal rule, Simpson's rule, Simpsons $3/8^{th}$ rule, Boole's Rule. Midpoint rule, Cmposite Trapezoidal rule, Composite Simpson's rule.

Ordinary differential equations: Euler's method. Runge-Kutta methods of orders two and four .

20 Lectures (3 question)

Books Recommended

1. Brian Bradie, A friendly introduction to Numerial Analysis, Pearson Education, India, 2007.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 6^{th} Ed., New age International Publisher, India, 2007
3. C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008 .
4. Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7^{th} Ed., PHI Learning Private Limited, 2013.
5. John H. Mathews and Kurtis D. Fink, Numerical Methods using Matlab, 4^{th} Ed., PHI Learning Private Limited , 2012.

SEMESTER –V

MAJOR COURSE – MJ-9

Credits-04 (60 Hs.), (Credits Lecture -03 Tutorial -01)
Full Makrs : 25(SIE: 1 Hs) + 75(ESE: 3Hrs)=100 Pass Marks (SIE:10+ESE:39=40

Semester Internal Examination (SIE):

There will be to group of questions Group **A is compulsory** and will contains two questions in wh ich question No. 1 contains five questions of **very short** type consisting of 1 mark each, and question No. 2 have one question of short answer type 5 marks. **Group B will contain descriptive type two questions** of 10 marks each, out of which any one is to answer.

End Semester Examination (ESE):

There will two group of questions. Group A is compulsory and will contain three questions. Question No. 1 will be very short answer type consisting of five questions of 1 mark each question No. 2 and 3 will be short answer type consisting two questions of 5 marks Group B will contain descriptive type six questions of fifteen marks each, out of which any four are to be answer .

Note: There may be subdivisions in each question asked in End Semester Examinations.

RIEMANN INTEGRATION AND SERIES OF FUNCTIONS:

UNIT: I

Riemann integration ; inequalities of upper and lower sums; Riemann conditions of integrability . Riemann sum and definition of Riemann integral through Riemann sums; equivalence of two definitions; Riemann integrability of monotone and continuous functions, Properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions. Intermediate Value thereorem for Integrals; Fundamental theorems of Calculus.

22 Lectures (2 question)

UNIT II

Improper integrals and their convergence, Convergence of Beta and Gamma functions.

Point wise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. Series of functions; Theorems on the continuity and derivability of the sum function of a series of functions. Cauchy criterion for uniform convergence and Weierstrass M-Test

23 Lectures (2 questions)

UNIT III

Limit superior and Limit inferior. Power series, radius of convergence, Cauchy Hadamard Theorem, Differentiation and integration of power series ; Abel's Theorem; Weierstrass Approximation Theorem.

15 Lectures (2 question)

Books Recommended :

1. K.A Ross, Elementrary Analysis. The Theory of Calculus, Underegraduate Texts in Mathematics, Springer (SIE) , Indian reprint, 2004
2. R.G. Bartle D.R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons(Asia) Pvt. Ltd., Singapore, 2002
3. Charles G. Denlinger, Elements of Real Analysis, Jones & Bartlett (Student Edition), 2011.

MAJOR COURSE – MJ-10

Credits-04 (60 Hs.), (Credits Lecture -03 Tutorial -01)
Full Makrs : 25(SIE: 1 Hs) + 75(ESE: 3Hrs)=100 Pass Marks (SIE:10+ESE:39=40

Semester Internal Examination (SIE):

There will be to group of questions Group **A is compulsory** and will contains two questions in wh ich question No. 1 contains five questions of **very short** type consisting of 1 mark each, and question No. 2 have one question of short answer type 5 marks. **Group B will contain descriptive type two questions** of 10 marks each, out of which any one is to answer.

End Semester Examination (ESE):

There will two group of questions. Group A is compulsory and will contain three questions. Question No. 1 will be very short answer type consisting of five questions of 1 mark each question No. 2 and 3 will be short answer type consisting two questions of 5 marks Group B will contain descriptive type six questions of fifteen marks each, out of which any four are to be answer .

Note: There may be subdivisions in each question asked in End Semester Examinations.

RING THEORY AND LINEAR ALGEBRA I :

UNIT I

Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring , Ideal , Ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals.

20 Lectures (2 questions)

UNIT II

Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III field of quotients .

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension , dimension of subspaces theorems.

25 Lectures (2 questions)

UNIT III

Linear transformations, null space, range, rank and nullity of a linear transformation, Matrix representation of a linear transformation, algebra of linear transformations, isomorphisms , Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix .

15 Lectures (2 Questions)

Books Recommended

1. John B, Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstrac Algebra, 2nd Ed., Pearson, 2011
3. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra , 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004
4. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, new Delhi, 1999.
5. S. Lang, Introduction to Linear Algebra , 2nd Ed., Springer, 2005.
6. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007
7. S.Kumaresan, Linear Algebra-A Geometric Approach, Prentice Hall of India, 1999.
8. Kenneth Hoffman, Ray Alden Kunz, Linear Algebra, 2nd Ed., Prentice- Hall of India Pvt. Ltd. , 1971
9. D.A.R. Wallace, Groups , Rings and Fields , Springer Verlag London Ltd., 1998 .

MAJOR COURSE – MJ-11

Credits-04 (60 Hs.), (Credits Lecture -03 Tutorial -01)
Full Makrs : 25(SIE: 1 Hs) + 75(ESE: 3Hrs)=100 Pass Marks (SIE:10+ESE:39=40

Semester Internal Examination (SIE):

There will be to group of questions Group **A is compulsory** and will contains two questions in wh ich question No. 1 contains five questions of **very short** type consisting of 1 mark each, and question No. 2 have one question of short answer type 5 marks. **Group** B will **contain descriptive type two questions** of 10 marks each, out of which any one is to answer.

End Semester Examination (ESE):

There will two group of questions. Group A is compulsory and will contain three questions. Question No. 1 will be very short answer type consisting of five questions of 1 mark each question No. 2 and 3 will be short answer type consisting two questions of 5 marks. Group B will contain descriptive type six questions of fifteen marks each, out of which any four are to be answer .

Note: There may be subdivisions in each question asked in End Semester Examinations.

MULTIVARIATE CALCULUS:

UNIT I

Functions of several variables, limit and continuity of functions of two variables Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability . Chain rule for one and two independent parameters, directional derivatives, Extrema of functiontions of two variables , method of Lagrange multipliers.

15 Lectures (2 questions)

UNIT II

Double integration over rectangular region, double integration over non-rectangular region. Double integrals in polar co-ordinates, Triple integrals, Triple integral over a parallepiped and solid regions. Volume by triple integrals, cylindrical and spherical co-ordinates. Change of variables in double integrals and triple integrals.

20 Lectures (2 questions)

UNIT III.

The gradient, maximal and normal property of the gradient , tangent planes Definition of Vector field, divergence and curl Line integrals, Applications of line integrals; Mass and Work Fundamental theorem for line integrals, conservative vector fields, independence of path, Green's theorem, surface integrals, integrals over parametrically defined surfaces . Stoke's theorem.

25 Lectures (2 questions)

Books Recommended :

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Brandley and K.J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education) , Delhi 2007.
3. E. Marsden, A.J. Tromba and A Weinstein, Basic Multivariable Calculus, Springer (SIE), Indian Reprint, 2005.
4. James Stewart, Multivariable Calculus, Concepts and Contexts, 2nd Ed:, Books / Cole, Thomson Learning , USA . 2001.

MULTIDISCIPLINARY COURSE (MATHEMATICS)

Subject Code – MDC

Course Credit :03
F.M. – 75 , P.M.-30

Total Lecture Hours:45
Time: 03Hrs.

Instruction to Question Setter for :

End Semester Examination (ESE):

There will ***two*** *group of questions.* ***Group A is compulsory*** *and will contain three questions.* ***Question No. 1 will be very short answer*** *type consisting of five questions of 1 mark each* ***Question No. 2 and 3 will*** *be* ***short answer type*** *consisting two questions of 5 maks.* ***Group B will contain descriptive type*** *six questions of fifteen marks each, out of which any four are to be answer.*

Note:- There may be subdivisions in each question asked in End Semester Examination .

CALCULUS :

UNIT-I

Limit and Continuity(ε *and* δ *definition*) , types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz's theorem, Partial differentiation, Euler's theorem on homogeneous functions.

(2 questions)

UNIT-II

Tangents and normals, Curvature, Asymptotes, Singular points, Tracing of curves. Parametric representation of curves and tracing of parametric curves, Polar coordinates and tracing of curves in polar coordinates.

(2 questions)

UNIT-III

Reduction formulae , length of curves, volume and area of surface of revolution .

(2 questions)

Books Recommended :

1. G.B. Thomas and R.L. Finney, Calulus, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K.J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P.Ltd. (Pearson Education), Delhi, 2007
3. H.Anton, I, Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
4. R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), Springer Verlag, New York , Inc., 1989.

NEP – 2020: Syllabus of UG Mathematics (Minor)

Undergraduate Certificate Courses, Mathematics (Minor)

Year	Semester	Paper Title	Study Materials	Credit
First (Introductory Courses)	I	Minor – 01 (Matrices & Trigonometry)	Unit – I: Rank of a matrix, elementary transformations of a matrix and invariance of rank through elementary transformations, normal form of a matrix, elementary matrices, rank of the sum and product of two matrices, inverse of a non-singular matrix through elementary row transformations, equivalence of matrices. Unit – II: Solutions of a system of linear equations, condition of consistency and nature of the general solution of a system of linear and nonhomogeneous equations. Unit – III: Trigonometric or circular and hyperbolic function of complex variable together with their inverses, De Moivre's Theorem and its applications, Euler's theorem, relation between trigonometric and hyperbolic function, Exponential function of a complex variable, Unit – IV: Logarithms of complex variable, Properties of logarithmic function, Separation into real and imaginary parts. Gregory's series, Value of π by different series, Summation of Trigonometric series by C+iS method based on Arithmetic Progression, Geometric Progression, Logarithms and Binomial expansions, Summation of Trigonometric series by difference method.	4
Undergraduate Diploma Courses, Mathematic (Minor)				
Second (Intermediate Level Courses)	III	Minor – 02 (Differential Calculus)	Unit – I: Functions of one variable, Limit of a function (ε-δ Definition), Continuity of a function, Properties of continuous functions, Intermediate value theorem, Classification of discontinuities, Differentiability of a function, Jacobians, maxima and minima of singe variable function, Rolle's Theorem, Mean value theorems and their geometrical interpretations, Applications of mean value theorems. Unit – II: Successive Differentiation, nth Differential coefficient of functions, Leibnitz Theorem, Taylor's Theorem, Maclaurin's Theorem, Taylor's and Maclaurin's series expansions. Unit – III: Geometrical meaning of tangent, Definition and equation of Tangent, Tangent at origin, Angle of intersection of two curves, Definition and equation of Normal, Cartesian sub tangent and subnormal, Tangents and normals of polar curves, Angle between radius vector and tangent, Perpendicular from pole to tangent, Pedal equation of curve, Polar sub tangent and polar subnormal, Derivatives of arc (Cartesian and polar formula). Unit – IV: Curvature, Radius of curvature, Cartesian, Polar and pedal formula for radius of curvature, Tangential polar form, Centre of curvature, Asymptotes of algebraic curves, Methods of finding asymptotes, Parallel asymptotes, existence and classification of singular points, points of inflection.	4

NEP – 2020: Syllabus of UG Mathematics (Minor)

Bachelor's Degree Courses, Mathematics (Minor)

Year	Semester	Paper Title	Study Materials	
Third (Higher Level Courses)	V	Minor – 03 (Integral Calculus)	Unit – I: Integral as a limit of sum, Properties of Definite integrals, Fundamental theorem of integral calculus, Summation of series by integration, Infinite integrals, Differentiation, and integration under the integral sign. Unit – II: Beta function, Properties and various forms, Gamma function, Recurrence formula and other relations, Relation between Beta and Gamma function, Evaluation of integrals using Beta and Gamma functions. Unit – III: Double integrals, Repeated integrals, Evaluation of Double integrals, Double integral in polar coordinates, Change of variables, Change of order of integration in Double integrals, Triple integrals, Evaluation of Triple integrals, Drichlet's theorem and its Liovelle's extension. Unit – IV: Area bounded by curves (quadrature), Rectification (length of curves), Volumes and Surfaces of Solids of revolution.	4
Bachelor's Degree with Hons./Research Courses, Mathematics (Minor)				
Fourth (Advanced Courses)	VII	Minor – 04 (Vector Analysis)	Unit – I: Triple product, Reciprocal vectors, Product of four vectors, General equation of a Plane, Normal and Intercept forms, Two sides of a plane, Length of perpendicular from a point to a plane, Angle between two planes, System of planes. Unit – II: Direction Cosines and Direction ratios of a line, Projection on a straight line, Equation of a line, Symmetrical and unsymmetrical forms, Angle between a line and a plane, Coplanar lines, Lines of shortest distance, Length of perpendicular from a point to a line, Intersection of three planes, Transformation of coordinates. Unit – III: Ordinary differentiation of vectors, Velocity and Acceleration, Differential operator-Del, Gradient, Divergence and Curl. Unit – IV: Line, Surface and volume integrals, Simple applications of Gauss divergence theorem, Green's theorem and Stokes theorem.	4

Question format for Semester Internal Examination 20 marks:

Subject / Code

F.M.=20 + 5 =25 Time: 1 Hr. Exam year

General Instruction:

1) Group A carries very short answer type compulsory Question
2) Anser I out of 2 subjective/ descriptive questions given in Group B
3) Answer in your own words as far as practicable.
4) Answer all sub parts of a question at one place.
5) Numbers on the right indicate full marks of the question.

Group A

[5 x 1=5]

1. i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....

2. ..... [5]

Group B

3. ..... [10]
4. ..... [10]

Note : There may be subdivisions in each question askd in Theory Examination

Question format for End Semester Theory Examination 75 marks:

Subject / Code

F.M.= 75 Time: 3 Hrs. Exam year

General Instruction:

1) Group A carries very short answer type compulsory Question
2) Answer 4 out of 6 subjective/ descriptive questions given in Group B
3) Answer in your own words as far as practicable.
4) Answer all sub parts of a question at one place.
5) Numbers on the right indicate full marks of the question.

Group A

[5 x 1=5]

1. i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]
9. ..... [15]

Note : There may be subdivisions in each question askd in Theory Examination