PROGRAMME PROJECT REPORT (PPR)
For Online Programme

Name of the Programme: **MASTER OF SCIENCE IN MATHEMATICS (M.Sc. in Mathematics)**

Duration: Minimum 2 years
Maximum 4 years

Recognition: ThisProgramme is recognized by the UGC-DEB.

A. PROGRAMME'S MISSION &OBJECTIVES

Mission:

The M.Sc Mathematics Online programme aims at preparing teachers, educators and other education professionals including curriculum developers, educational policy analysts, planners, administrators, supervisors and researchers.

The M.Sc. in Mathematics Programme aims;

- To strive to become internationally recognized for academic excellence through the depth of its teaching and research, and to be locally relevant through its role in the development of the community it serves.
- Try to maintain the publication rate and to improve the much better quality in research work. To highlight our Department as one of the best Department in our state as well as in the country.
- Motivating students to automate various office activities which are done manually as projects.
- Organizing technical sessions with IT experts.
- Teaching by using technology such as using smart board etc.
- Delivered classes through power point presentation.
- Conduct seminars weekly for students and monthly for research scholars.
- Based on student's feedback necessary improvement steps are being taken.
- Conducting many events like technical competitions, group discussions, mock tests, computer scientist's birthday celebration events and poster presentations which makes students to participate actively.
- Conducting internal assessment and practical tests.
- Research and Development (R&D) and industry oriented seminars and invited talks.

Objectives:

After completion of the programme the learner will be able to

- To negotiate with the Modern and Traditional Knowledge's regarding mathematics.
- To empower the students to become global teachers and in-turn to create competent, creative students for nation building.

- To prepare the students to become holistic persons with diverse learning experiences and productive thinking in a global society.
- Transforming the hidden potentialities of the students into realities

B. RELEVANCE OF THE PROGRAM WITH HEI'S MISSION AND GOALS

Kuvempu University is an affiliating State University in Karnataka. Established in 1987, it is the University with a distinctive academic profile, blending in itself commitment to rural ethos and a modern spirit. It has 37 Post-Graduate departments of studies in the faculties of Arts, Science, Commerce and Education.It also has 4 constituent colleges at Shankaraghatta and Shivamogga, and two outlying regional Post-Graduate Centers at Kadur and Chikmagalur.

The Vision and Mission of the University are:

Vision:

Kuvempu University shall strive to become an international center of excellence in teaching and research to provide high quality value based education to all through various modes to meet the global challenges.

Mission:

Foster creativity in teaching, learning and research to build a knowledge base and promote quality initiative.

Provide access to education to all.

Develop human resources to meet the societal needs.

The Distance Education and Online Programmes are a part of the University's outreach programmes for the rural masses and also to foster University-Society relationship with the motto of "**Education for All**"., to provide quality education at the doorsteps of desirous individuals who want to take up higher education, for the discontinued who could not take up formal education, housewives and employees who want to improve and enhance their knowledge. The University firmly believes that education and seeking knowledge is a **Lifelong Learning** concept.

Offering higher education through Distance and Online modes is an important step taken by Kuvempu University so as to help the student community in their zeal to pursue higher educationboth at UG and PG Level. The University felt the necessity of this when a large number of students, who wanted seats for PG. Studies, could not be accommodated in our regular P.G. Programmes. The University believes that Distance and Online Education Modesarean equally good avenue to be made available to interested students/ Learners. With these views, Kuvempu University started offering courses through distance mode since 2002-2003. At present it is offering 31 Programmes (earlier called Courses) in various faculties at the U.G., P.G. and PG Diploma levels. These courseswere approved by the erstwhile DEC-IGNOU, and now by the UGC-DEB.

Further, the University believes that the Online mode of education is also an important platform to reach out to the wider population and it is the need of the present situation wherein, the internet and communication technologies are available to the majority of the population in the country.

Goals & Objectives of Online Mode Programme

- Reach out to larger sections of the society, who are willing to seek education through non-formal platforms.
- Capacity Building by using the non-formal mode platform.
- Concentrate on planning & constant upgradation of facilities tomeet new challenges in education through Online Mode.
- Provide counseling & consultancy to students.
- Offer area/ region wise educational requirements**.**
- Skill Development and Enhancement.
- To impartquality training through interactive learning module.
- Interactive Pedagogy of teaching-learning and flexible learning environment.
- Provide supportive academic environment and effective teaching.

C. NATURE OF PROSPECTIVE TARGET GROUP OF LEARNERS:

The Master of Science in Mathematics programme, generally known as M.Sc in Mathematics is designed for the large group of upper primary / middle level teachers, at all education levels. This programme looks for not only enhance language skills but also intended to make sense of literary appreciation. Most of the target group intended for developing there literary creativity and also able to enjoy literary creation of important Mathematics writer.

- Successfully qualified graduates from this course can be employed in any education institutions including universities.
- Students who studied this course can able to enhance creative activity.
- Learners who are not able to get an opportunity to read and appreciate mathematics in regular mode due to financial crisis than able to acquire knowledge literary sense.
- Learners with different disciplines will be able to indulge in recent literary activity through this programme.
- Qualified graduates in any stream who have studied Mathematics at graduation level from any recognized University who wish to see their career development in teaching literature.
- Persons who love to spent their quality time with students and want to enrich skills.
- Persons who are not able to pay higher fees in regular mode (Affordable Fee structure). Home makers who want to enhance their career.
- Young entrepreneurs who wish to acquire managerial skills through teaching.
- For the Persons who want to appear for competitive exams this Programme is very useful.
- Online programme degrees are recognized as equivalent to the regular mode degrees by the UGC.

D. APPROPRIATENESS OF PROGRAMME TO BE CONDUCTED IN ONLINE LEARNING MODE TO ACQUIRE SPECIFIC SKILLS AND COMPETENCE

M.Sc.,in Mathematics programme helps to develop in prospective teacher educators, educational administrators, and Heads of Schools and college's skills related to independent study of literature, research, academic writing, professional communication and team work it should also endeavour to develop in the future practitioners a deep and critical awareness of professional ethics and an ability to critically engage in and reflect on practice.

Mathematics Department is one of the best Department in our university where excellence in knowledge, research, creativity and innovation come together to produce next generation of thoughtful leaders in academia and across a multitude of ways that chart the national and global futures. Also, the department has been harnessing precious human resources for the overall development of society through the pursuit for excellence in the area of Mathematical Sciences.

Further, the Programme develops ability to apply acquired knowledge and solve problems in new or unfamiliar surroundings within broader (or multi-disciplinary) contexts related to the area of study. The Programme aims to build among our graduates capabilities for ongoing self-motivated professional development. The programme would provide learners a wider and more comprehensive understanding of education as field of knowledge and would accommodate a wide variety of learning needs of learners.

E. INSTRUCTIONAL DESIGN:

(i) Programme Formulation:

Proposal from the concerned PG department to commence the programme was placed before Monitoring Committee of the DDE/Syndicate. After its approval it will be referred to the BOS concerned parent department for the formulation and approval of the syllabus, scheme pattern, time allotment for each course, marks and credit allotment, scheme of examination etc, After BOS approval it was placed in the Faculty meeting and then Academic Council (the highest body) of the University for its approval. After approval by Academic council, the programme was introduced. The academic advisory body of DDE refers the matter to the concerned subject/parent department council for preparation of learning materials. The concerned subject faculty will coordinate with the DDE and the department council, as he/she is on the member in it. Workshops for the faculty in preparing e-content/study material in self learning mode are regularly conducted (with the help of IGNOU experts).

(ii) Curriculum Design:The Programme is of 2 years duration with four semesters. The maximum period allowed to complete the programme by a learner is 4 years (double the duration). The Programme structure is as below.

SEMESTER – I:

	COURSE CODE	SUBJECT	MARKS ALLOTMENT		TOTAL	CREDIT
			EXAM	IA		
Hard Core	MSM 1.1	ALGEBRA	80	20	100	06
	MSM 1.2	ANALYSIS-I	80	20	100	05
	MSM 1.3	ORDINARY DIFFERENTIAL EQUATION	80	20	100	06
	MSM 1.4	COMPLEX ANALYSIS-I	80	20	100	04
Soft core	MSM 1.5	DISCRETE MATHEMATICS	80	20	100	04
TOTAL					**500**	**25**

SEMESTER – II:

	COURSE CODE	SUBJECT	MARKS ALLOTMENT		TOTAL	CREDIT
			EXAM	IA		
Hard Core	MSM 2.1	LINEAR ALGEBRA	80	20	100	06
	MSM 2.2	ANALYSIS – II	80	20	100	05
	MSM 2.3	PARTIAL DIFFERENTIAL EQUATION	80	20	100	06
Soft core	MSM 2.4	COMPLEX ANALYSIS-II	80	20	100	04
	MSM 2.5	GRAPH THEORY	80	20	100	04
TOTAL					**500**	**25**

SEMESTER – III :

	COURSE CODE	SUBJECT	MARKS ALLOTMENT		TOTAL	CREDIT
			EXAM	IA		
Hard Core	MSM 3.1	MEASURE THEORY AND INTIGRATION	80	20	100	06
	MSM 3.2	TOPOLOGY-I	80	20	100	05
	MSM 3.3	NUMERICAL ANALYSIS-I	80	20	100	05
Soft core	MSM 3.4	DIFFERENTIAL GEOMETRY	80	20	100	04
	MSM 3.5	FLUID MECHANICS	80	20	100	04
TOTAL					**500**	**24**

SEMESTER – IV :

	COURSE CODE	SUBJECT	MARKS ALLOTMENT		TOTAL	CREDIT
			EXAM	IA		
Hard Core	MSM 4.1	FUNCTIONAL ANALYSIS	80	20	100	06
	MSM 4.2	TOPOLOGY-II	80	20	100	05
Soft Core	MSM 4.3	NUMERICAL ANALYSIS-II	80	20	100	05
	MSM4.4	RIEMANNIAN GEOMETRY	80	20	100	04
	MSM 4.5	MAGNETOHYDRODYNAMICS	80	20	100	04
TOTAL					500	24

Sl.No.	Semester	Total Marks	Credits
1	1st Semester	500	25
2	IInd Semester	500	25
3	IIIrd Semester	500	24
4	1Vth Semester	500	24
	GRAND TOTAL	**2000**	**98**

Medium of Instruction:

The medium of instruction shall be English.

(iii) Detailed syllabi: Given as Appendix-01

(iv) Faculty and Supporting Staff Requirement

Full time faculty in regular department and DDE are involved in Online programmes. Course Coordinator of the programme, who is a regular faculty member and the Research and Teaching Assistant (RTA) will be in-charge of the Programme, They will address the day to day academic and learner/student support aspects of the Programme.

Regarding supporting staff, DDE has a separate and well equipped wing/office to take care of all the administration and delivery aspects of Online Programmes.

There is a separate ODL and OL wing in the Office of the Registrar (Evaluation) for all the evaluation and certification aspects headed by a Deputy/Assistant Registrar.

The DDE and Evaluation wings are fully computerized and technical staff assist in all the activities.

(v) Instructional Delivery Mechanism

Instructional delivery mechanism is through e-learning / online materials prepared by the experts in the subjects concerned. E-materials (SLM) are prepared in-house by the faculty of the department and the faculty from sister universities.

The e-material provided is the general guide and covers the course content inorderto make the learner to understand core content of the course concerned. Learner are advised to make use of the reference books and a pen web resources given in the list of books provided along with the syllabus.

E-tutorials and discussion forums: There will be e-tutorials for a required / minimum no. of days normally. A minimum of 15 days for instruction by experienced and scholarly faculty will be arranged for each Course. There shall be interaction built around lectures, discussions, individual and group activities. Test will be conducted for the candidates in each course at the end of e-tutorials programme.

Student support service: Students can interact with the Office/Faculty through e-mails and personal visits. SMS alert facility for the students regarding dissemination of information relating to conduct of e-tutorials and Project submission deadlines etc. Student Support Service is provided through online mode and grievance handling mechanism is adopted with the help of supporting technical staff. All necessary and relevant information are uploaded in the dedicated website: www.kuvempu.ac.in(Distance and Online section). Internal Assignments with Guidelines, previous years question Courses, notifications timetables and results are available from the website.

F. PROCEDURE FOR ADMISSIONS, CURRICULAM TRANSACTION AND EVALUATION:

As outlined in Section-B, Kuvempu University has a policy to provide opportunity to maximum number of eligible and desirous candidate from all sections of the Society including classes having of low-level of disposable income, rural dwellers, women unskilled men minorities etc.

(i) Eligibility for the Programme

For the post graduate course in M.Sc., Mathematics, the candidate should passed three/Four year Degree examinations of any recognized university with mathematics as one of the Major Subject.

All the candidates who fulfill eligibility criteria are admitted to the programme. If university decides for maximum number of candidatesfor the Programme, admissions are made first come first basis.

(ii) Admission Process

- Notification shall issued by the Directorate of Distance Education and Online Programmes in Regional and National News Courses and in the official website.
- Uploading of the Application by the candidate through Online only.
- Payment of fee through digital or e-payments (various options like net banking etc.).
- Submission of the printout of the application by the candidate to DDE alongwith original documents for eligibility, date of birth etc., and with fee paiddocument.
- Verification of applications- forfulfillment of eligibility criteria (marks cards) documents, fee paid details.
- Approval of the admission and issue of e-learning/ SLM material to the students.

(iii) Fee Structure

Detailed fee structure (Semester wise) shall be notified separately by the Directorate of Distance Education. Fee structure is subject to upward revision annually with the approval of the authority, of the university

Financial Assistance:

- SC/ST and OBC Students can avail scholarship/fee reimbursement from the concerned State Departments/Agencies

- Fee Concession to Physically Handicap candidates.
- Fee concession to Employees of the University and their dependents.
- Fee concession to Ex- servicemen.
- Scholarships and education supports extended by various Governmental and Non-Governmental agencies.

(iv) Academic Calendar / Activity Planner (General)

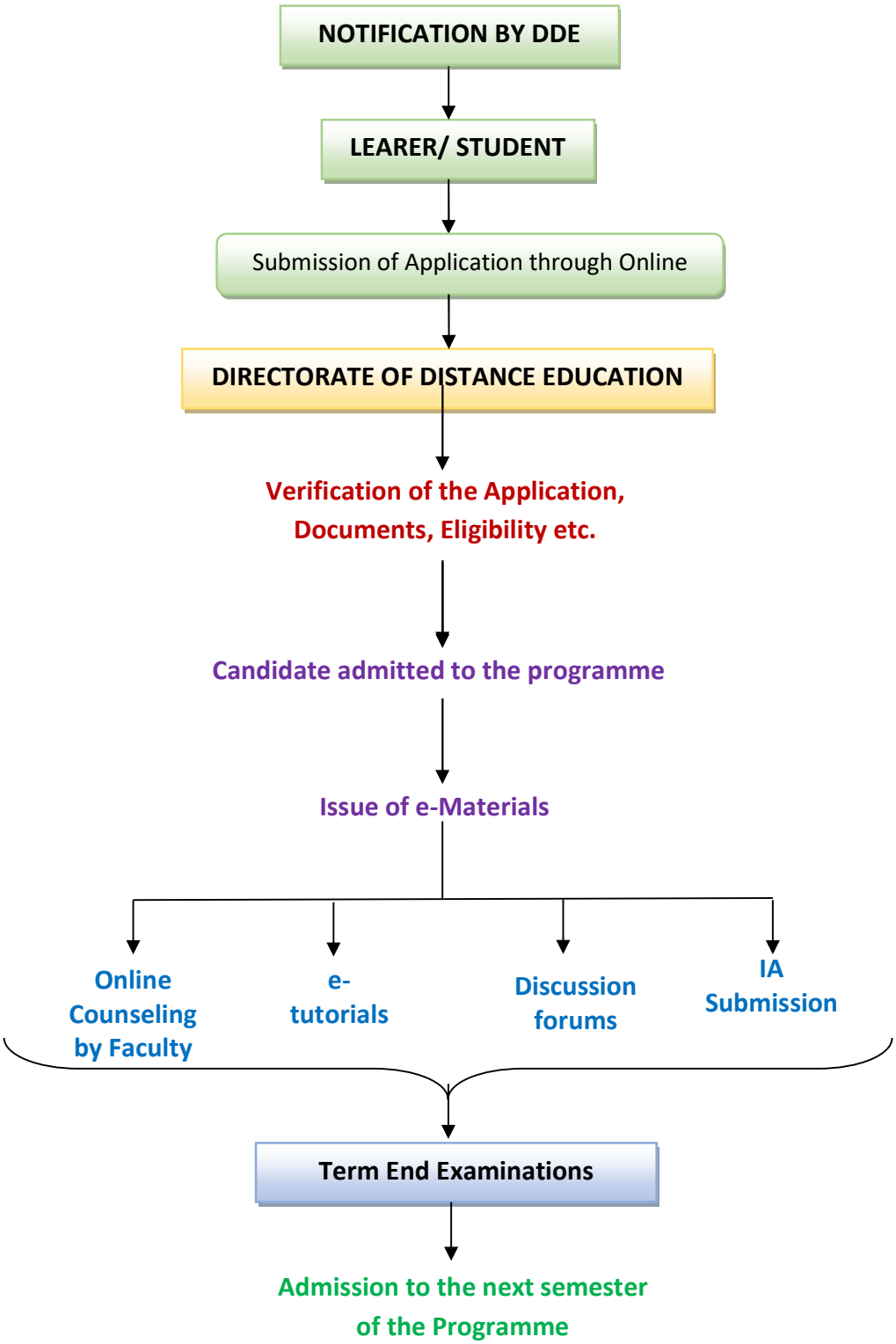
Session:1 – July Cycle

SN	Name of the Activity	From (Month)	To (Month)
1	Admissions	July I week	September end
2	Distribution of Learning Material	July	September
3	Counseling/ e-tutorials / discussion forums	September	November
4	Assignment Submissions	November	November
5	Evaluation of assessments	November	November
6	Examination	December	December
7	Declaration of Results	January end	February
		(of next calendar year)	
8	Registration to next semester	January I week	February end

Session:2 – January Cycle

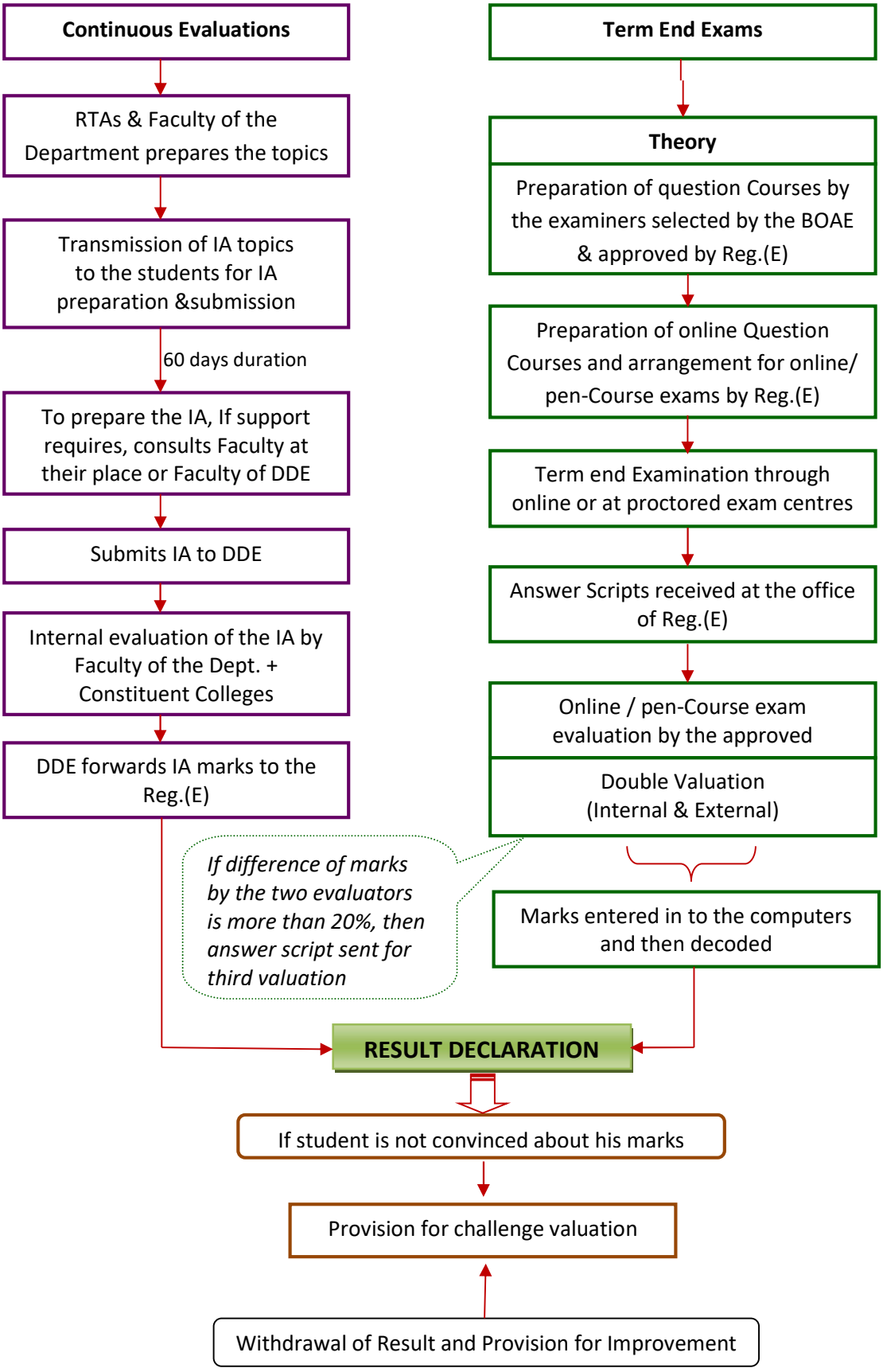
SN	Name of the Activity	From (Month)	To (Month)
1	Admissions	January I week	February end
2	Distribution of Learning Material	January	February
3	Counseling/ e-tutorials / discussion forums	March	April
4	Assignment Submissions	March	April
5	Evaluation of assessments	May	May
6	Examination	June	June
7	Declaration of Results	July	August
8	Registration to next semester	July I week	August end

Generalised Academic Flow Chart for the Distance Mode Learners



(v) Evaluation of Learner Progress

Evaluation Process is given here in the form of Flowchart.



Internal Assessments:

- As a part of continuous assessment the Learner will be provided with online/offline assignments and learners to submit them to the concerned Coordinator within the specified date. The Topics & Instructions for I.A. will be notified in the Students Corner section of the website and also issued to the learners through e mails.

- It is mandatory to submit the I.A. in the same semester session of registration. However, if the candidate fails to take up the term end examination, for any reason, such candidate can submit the I.A. in the next year with prior permission from the cordinator.

- All students are expected to complete the above assessments before taking the Term end Examination.

- There is no provision for resubmission of I.A.

Provision for class tests and workout exercises: during e-tutorials and discussion forums.

(vi) Term End Examination:

Duration:3 hours, **Maximum marks:** 80

Questions pattern: There shall be multi-choice descriptiveor objective type questions in each of the courses. The marks for each questions may vary based on objective type/ short answer / long answer questions.

Declaration of class: After successful completion of the Programme/ evaluation the class will be awarded on the basis of the aggregate of marks all semesters.

Pass Class	:	40% of marks or above but below 50% of marks.
Second class	:	50% of marks or above but below 60% of marks.
First Class	:	60% of marks or above.

Separate Ranks and Medals are awarded to Online Learners. Policy for awarding ranks and medals are same as the one followed for the Regular modeProgramme.

Re-appearing for Exams: Unsuccessful candidates in the Term end Examinations of a semester are required to reappear for those courses/examinations only as per the syllabus of that year. The repeaters are therefore advised to preserve the syllabus and e-material until they pass the final year of the course. Learners can upload their repeater application directly through Online after the notification issued for the same from the Registrar (Evaluation).

Learners will have to complete all the exams within double the duration of the programme(and not the number of attempts). The double the duration is reckoned from session of the year of registration.

A candidate is permitted to register for the subsequent examination irrespective of the number of courses failed at the previous term end exams.

(vii) Other Policy/Provisions

Renewal of Registration: Students who have not registered for the subsequent semestersimmediately after the completion of first / pervious semester due to any personal/unforeseen reason, they can reregister in the subsequent sessions. They have to pay a Programme fee plus nominal re-registration fee based on number of sessions lapsed. However they should complete the Programme within the maximum permissible period,ie., 4 years.

Bonafide student certificate: Those candidates who require Bonafide Certificate/ Study Certificate can obtain by submitting a written request or a filled in prescribed application form (available from the University website) along with specified fee paid either through digital / e-payment provisions.

Change of Address: Any change in the address of the students should be intimated to the Directorate immediately along with the specified fee payment. No change of address will be entertained once the students receive their examination hall ticket. The Directorate of Distance Education is not responsible for missing correspondence due to change of address without getting address changed at DDE.

Name Correction: Change of Name, if only wrongly entered by the learner in the online, he/she has to make a written request along with relevant documents as proof of change of name, and by paying specified fee.

Duplicate Registration Card: For issue of duplicate Admission/Registration/ Enrollment card specified fee will be charged.

Transfer Certificate: A Transfer Certificate is not required for admission to any of the KUDDE programme. The Directorate will also not issue Transfer Certificate at the time of completion of the programme.

Change of Examination Centre: DDE will not entertain any change of proctored examination centre unless there is a proof of change of address and it is permissible.

Discrepancies in Marks cards and certificates: In case of any discrepancies observed in the marks card/ certificates etc., candidates have to bring it to the notice of the Registrar (Evaluation), through online within a period of 3 months from the date of issue of the document. Certification issues / requests are addressed through **ParikshaMitra** banner in the University website.

Miscellaneous: All the original certificates submitted by the candidates in connection with their admission, registration will be returned to them from the Office of the DDE along with the registration certificate. In case any of their certificates are not received back, they must bring the same to the notice of The Director, DDE, Kuvempu University, immediately.

Preservation of Answer Scripts / IA Scripts: The pen-Course mode examination/ assignments/ answer scripts of term-end Exams will be preserved for a maximum duration of 3 months from the date of announcement of results/ revaluation / challenge valuation results. Any query or request for verifications may be submitted through online within the notified period only.

Any discrepancy observed regarding IA marks, written / online, request may be submitted to DDE within one month from the date of issue of results. Later request may not be accepted.

Students are advised to refer the website for notifications regarding preservation of various documents, issued from time to time.

Notwithstanding any conditions mentioned above the University reserves the right to change, alter, and amend any of the above clauses/conditions. In matters of fees for unforeseen issues / certificates/ endorsements the University may fix the amount subject to the existing fee structure or change it from time to time.

Post-Examination Related Issues: Submission of applications for Convocation (Degree) Certificates, Duplicate Marks Cards, Provisional Pass Certificate (PPC), Name Correction, Consolidated Marks Cards, removal of NCL, Academic Transcript, verification of genuineness of Marks Cards and Certificates, and Processing Certificates can be done through online. Learners can directly apply online for the same. For all enquiries and clarifications regarding said issues Learners can contact the DDE Section in the Office of the Registrar (Evaluation). Contact details, telephone and e-mail ID, of the Helpdesk at the O/o the Registrar (Evaluation) are given in the website.

G. LIBRARY RESOURCES

A well established library facility shall be made available with the support of the university library. In the campus we have modern and well equipped library in Kuvempu University with excellent infrastructure facilities for reading, browsing and reference to the students, teachers and research scholars. The library has kept pace with modernization by introducing CD ROM data base, internet and e-mail facilities. It is also a nodal centre for INFLIBNET, access is available to 10,000 + e-journals online under the UGC- infonet Consortia. There is a well developed digital library and campus network interconnecting all the Post-Graduate departments and offices in the campus.

Further, Learners can access the Open and Online learning platforms such as Swayam, MOOCs and such other UGC approved provisions. DDE shall arrange to send the e-materials to the learners directly.

H. COST ESTIMATE OF THE PROGRAMME AND THE PROVISIONS

Cost Estimated of the Programme is based on following components
– calculated for an admission of 100 Students:

SN	Component	App.Estimate (in Lakh Rupees)
1	e-content/ SLM Development – Course Writer honorarium, Review setting, editing, SLM conversionetc.	4.32
2	Publicity, Awareness Information Decimation Programmes*	0.15
3	Conduction of Counselling, e-tutorials, etc.	2.22
4	Student Support Services*	0.30
5	TA/DA Meeting Expenses*	0.17
6	Continuous Evaluation / IA	0.18
7	Examination and Certification	2.33

8	Office Automation/ICT/ CommunicationRelated Infrastructure*	0.34
9	Library / Digital resources*	0.22
10	Staff Salaries/ Remunerations/ Other Honorariums – Teaching, Nan-Teaching/Technical/Supporting*	2.00
11	Office Infrastructure*	0.24
12	Proctored Examination Centre Expenses*	0.26
13	Others – Office Contingence, Post/Courier, Vehicle Maintenance, Fee reimbursement and such others. *	0.58

Note: * costs that will be incurred collectively for all the Programmes, but given here are the fractions of the total, considering 100 students admission to the Programme.

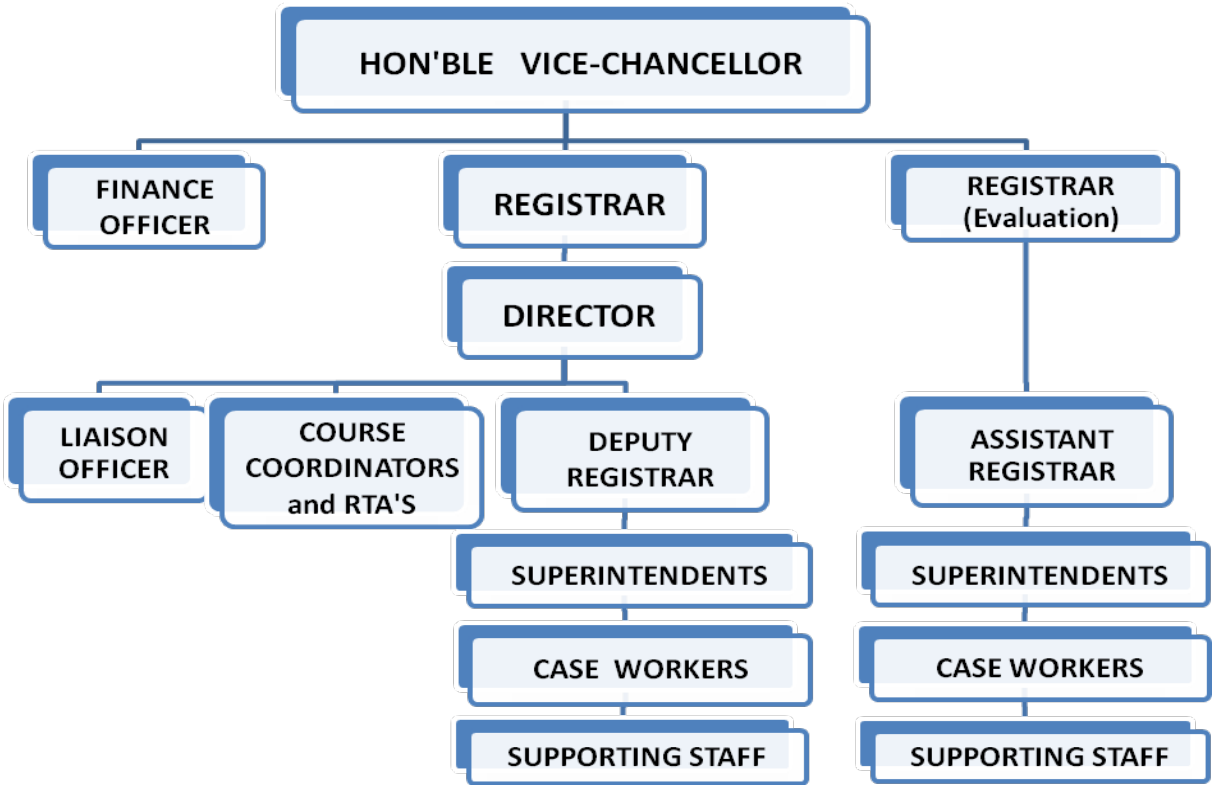
I. QUALITY ASSURANCE MECHANISM AND EXPECTED PROGRAMME OUTCOMES

(a) Organizational Structure, Management and Monitoring Mechanism

The Organizational Structure of the Kuvempu University Directorate of Distance Education (KUDDE) is given below in the form of flowchart.

For the administrative and policy decisions, and reviewing and monitoring of the ODL and OL activities, Kuvempu University has a Monitoring Committee (MC) Chaired by the Honorable Vice-Chancellor. The Registrar, Registrar (Evaluation), Finance Officer, Deans of all the Faculties, Chief Librarian, One Syndicate Member, One Academic Council Member and the Regional Director of the IGNOU, are its members. The Director, DDE is the Organising Member. The operational plans, goals and policies are decided by the MC, and all the decisions and policy matters are placed before the Monitoring Committee before implementation. The Committee normally meets twice a year to review the ODL Programmes and activities.

Academic Advisory Committee (AAC) of the DDE will review the academic programme performance, content delivery mechanism. Issues regarding course content and syllabi revision of all the Programme offered in ODL mode are discussed and decided in AAC. The Registrar will be the Chairman of the AAC, and Registrar (Evaluation), Chairpersons of all BOSs of the concerned Departments will be the members. The Director/ Deputy Director of the DDE is the Organising Member.



All the major decisions including financial, planning and implementation which are discussed in the MC meeting are placed before the Syndicate of the University and after its approval they will come into force.

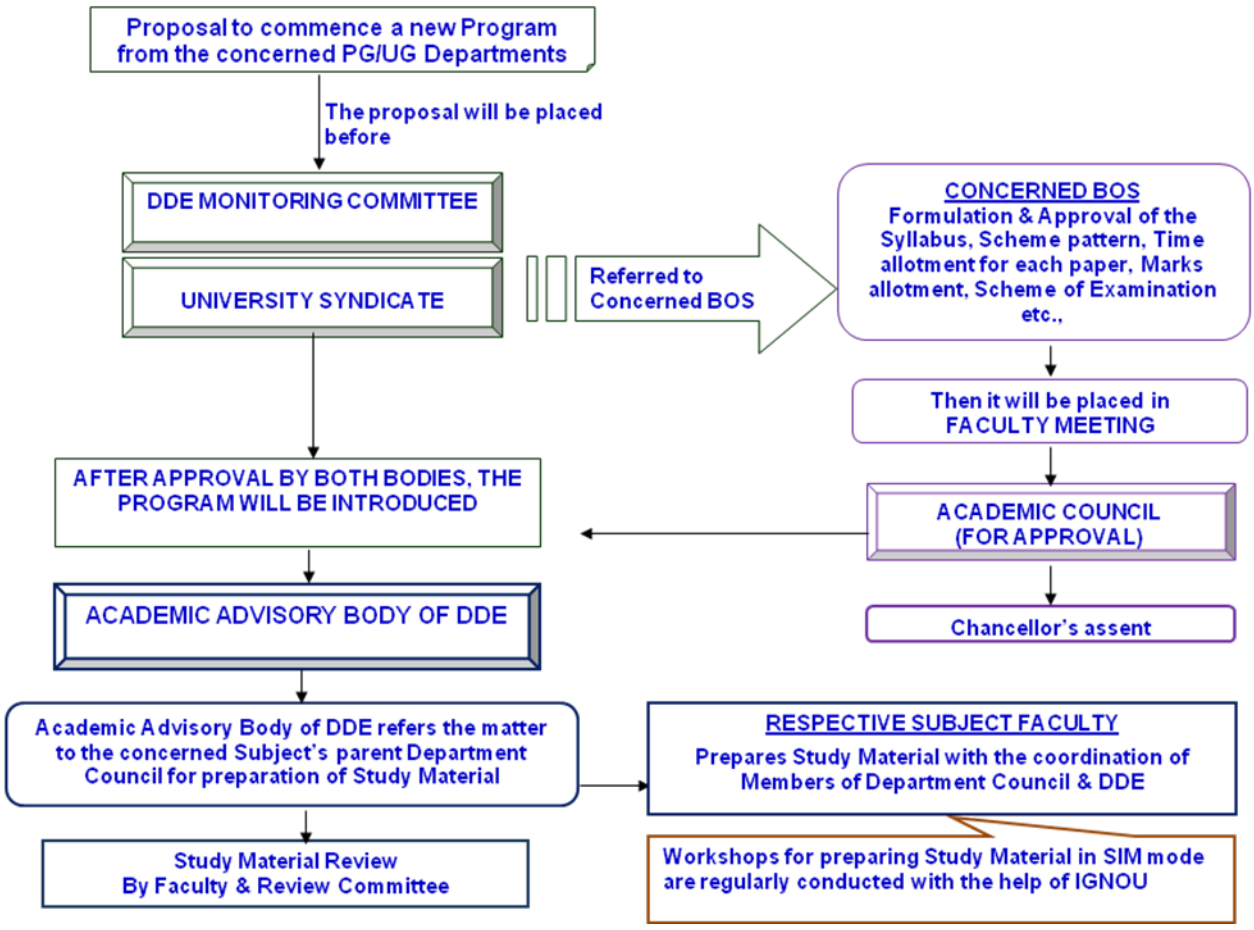
The decisions taken by the AAC are placed through the concerned bodies like, BOS/ Examination wing (for evaluation and certification issues) and finally placed before the Academic Council of the University for its approval.

For the internal quality assurance mechanism there is a separate body of Centre forInternal Quality Assurance Cell headed a Director and senior faculty members from faculties will be the members of the committee.

(b) Programme Development and Approval Processes.

Proposal from the concerned PG/ UG department to commence a new Programme will be placed before Monitoring Committee of the DDE/ Syndicate. Then it will be referred to the concerned BOS for formulation and approval of the syllabusand Program Project Report.Programme structure, time allotment for each Course, marks allotment, scheme of examination etc. are fixed by the BOS, then it will be placed in the Faculty meeting and then Academic Council for its approval. After approval by both the bodies, the programme will be introduced. The Academic Advisory Body of DDE refers the matter to the concerned Subject's/ parent Department Council for preparation of e-Material. The concerned subjectfaculty will coordinate with the DDE and the Department Council, as he/ she is one of the member in it. Workshops for preparing e-Material in SLM mode are regularly conducted and preparation of course material in SLM mode is in progress.

The various steps involved in programme development, approval and implementation are depicted in the flowchart given below.



(c) Programme Monitoring and Review

As a part of the regular monitoring mechanism, feedback from the Learners is obtained at the end of each of the face-to-face programmes - both through discussion and through written/online feedback form. Feedback form includes mainly three aspects – about appropriateness/ usefulness of learning (study) materials, effectiveness of orientation/ each semester sessions and internal assessments/continuous assessment process. Learner can give their opinion, suggestions and complaints, if any, through the online feedback form. Issues raised in feedback are addressed at appropriate level.

There is also Learner Support Service and Grievance Cell in DDE in order to address the day-to-day issues faced by the Learners. The Faculty /Research and Teaching Assistants at DDE and the Coordinators of the concerned subjects/ courses are available for the learner support services. These apart, regular meetings of concerned faculty are conducted in order to plan the programme delivery and practical sessions activity.

It is the policy of the KUDDE to make available the expert faculty of the PG Departments/ Colleges (for UG) and experts from the sister universities in the state who are regular faculty in the respective subjects for the ODL and online programmes.

Appendix-1

FIRST SEMESTER

Course-MSM 1.1: ALGEBRA (Max marks: 100=80+20. Credits: 06)

UNIT-1: Groups: Definition and examples of groups, Subgroups, abelian groups, cyclic groups, Lagrange's theorem, normal subgroups and quotient groups, homomorphism, isomorphism, Cauchy's theorem for abelian groups, application of Cauchy's theorem, automorphism, inner and outer automorphism.

UNIT-2: Permutation Groups: Examples, orbit, cycle, transposition, alternating groups, Cayley's Theorem, Conjugate class, class equation, Cauchy theorem for finite groups,

UNIT-3: Sylow's Theorem and Problems: solvable groups, direct products, Fundamental theorem on finite abelian groups.

UNIT-4: Rings: Definition and examples of Rings, Integral domain, Field, Characteristic of a Ring, Homomorphism, Kernal, isomorphism, ideals and quotient rings, maximal ideal, prime ideal, principal ideal ring.

UNIT-5: Euclidean Ring: Definition and examples, greatest common divisor, prime and irreducible elements, unique factorization domain, unique factorization theorem.

UNIT-6: Polynomial Rings: Division Algorithm, irreducible polynomial, primitive polynomial, Gauss Lemma, Eisenstein criterion, polynomial ring over commutative rings.

UNIT-7: Extention Fields: Definition and example, algebraic extension, transitivity of algebraic extension, roots of polynomial, Remainder Theorem, Factor theorem.

UNIT-8: Splitting Fields: Degree of Splitting fields, Normal extension, criterion for polynomial to have a multiple root in any extension field, characteristic of a ring, separable element, perfect fields.

References

1. *Topics in Algebra*: ISBN-9971-512-53-X : I.N.Herstein
2. *A First course in Abstract Algebra* : J.B.Fraleigh
3. *Algebra* : Michael Artin

Course-MSM 1.2: ANALYSIS-I (Max marks: 100=80+20. Credits: 05)

UNIT-1: Real Number System: Ordered sets, Fields, Real field, Extended real number system, Euclidean spaces.

UNIT-2: Basics of Set theory: Ordered pairs, Relation and functions, one-to-one correspondence, equivalent sets, cardinal number, finite and infinite sets, Countable and uncountable sets with examples.

UNIT-3: Basic Topology: Metric spaces, Open sets, Closed sets, Compact sets, Perfect sets, Connected sets.

UNIT-4: Numerical Sequence and Series: Convergent sequences, subsequences, Cauchy sequences, some special sequences, Series, Series of non-negative series, summation by parts, absolute convergence, addition and multiplication of series, Rearrangement.

UNIT-5: Continuity: Limits of function, Continuous function, Continuity and Compactness, Continuity and Connectedness, Discontinuity, Monotonic functions, Infinite limits and limits at infinity.

UNIT-6: Differentiation: The derivative of a real function, Mean value theorems, The continuity of derivatives, Derivatives of higher order, Taylor's theorem, Differentiation of vector valued functions.

References

1. *Principles of Mathematics Analysis*: ISBN-0-07-085613-3 : Walter Rudin
2. *Methods of Real Analysis* : R.R. Goldberg
3. *Mathematical Analysis* : T.M.Apostal

Course MSM 1.3: ORDINARY DIFFERENTIAL EQUATIONS

(Max marks: 100=80+20. Credits: 06)

UNIT-1: First Order Linear Differential Equations: Introduction, first order linear differential equations, separable equations, exact equations, Bernoulli's equation and method of substitutions.

UNIT-2: Higher Order Linear Differential Equations: Homogeneous equations and general solutions; Initial value problems; existence and uniqueness of solutions, linear dependence and independence of solutions, Solutions of nonhomogeneous equations by Method of Variation of parameters, Method of Undetermined Coefficients. Homogeneous equation of order n, initial value problems, Non-homogeneous equations. Linear equations with variable coefficients, reduction of order of the equation.

UNIT-3: Oscillations of Second Order Equations: Introduction, Oscillatory and non-Oscillatory differential equations and some theorems on it. Boundary value problems; Sturm Liouville theory; Green's function.

UNIT-4: Solution in Terms of Power Series: -Solution near an ordinary point and a regular singular point–Frobenius method–Legendre, Bessel's andHypergeometric equations and their polynomial solutions, Rodregue's relation, generating functions, orthogonal properties, and recurrence relations.

UNIT-5: Successive Approximations Theory: Introduction, solution by successive approximations, Lipschitz condition, Convergence of successive approximations, Existence and Uniqueness theorem (Picard's theorem),

UNIT-6: System of First Order Equations: First order systems, Linear system of homogeneous and non-homogeneous equations (matrix method) Non-linear equations-Autonomous systems-Phase plane-Critical points–stability-Liapunov direct method-Bifurcation of plane autonomous systems.

References

1. *An Introduction to Ordinary Differential Equations* : Eurl A. Coddington
2. *Differential equations with Applications & Historical Notes*: Simmons G.F
3. *Theory of ordinary differential equations* : M.S.P.Eastham
4. *Differential equations* (3rd edition) :S.L.Ross
5. *Ordinary Differential Equations and Stability Theory* :Deo SG and Raghavendra V
6. *Theory of ordinary differential equations* :A.Coddington and N.Levinson
7. *Differential equations* : A.C.King, J.Billingham and S.R.Otto

Course-MSM 1.4: COMPLEX ANALYSIS-I (Max marks: 100=80+20. Credits: 04)

UNIT-1: Introduction to Complex Numbers: Definition of complex numbers, arithmetic operations, square roots, conjugation, absolute value, Cauchy' inequality, geometry of complex numbers, stereographic projection.

UNIT-2: Analytic Functions: Limits, continuity and differentiability of complex valued functions, Cauchy-Riemann equations, Laplace equation, harmonic functions, polynomials, Lucas's theorem.

UNIT-3: Power Series: Sequence and series-review, uniform convergence, radius of convergence, power series as an analytic function, Abel's limit theorem.

UNIT-4: Conformal Mappings: Arcs and closed curves, analytic functions in regions, principle of conformal mapping, length and area.

UNIT-5: Mobius Transformation: Matrix interpretation and group structure, fixed points, cross ratio and its invariance property, principle of symmetry.

UNIT-6: Complex Integration: Line integral, rectifiable arcs, line integrals as functions of arcs, Cauchy's theorem of rectangle, Cauchy-Goursat theorem, Cauchy's theorem in a disk.

UNIT-7: Cauchy's Integral Formula: Index of a point with respect to a closed curve, the integral formula, representation formula.

UNIT-8: Higher Derivatives: Morera's theorem, Liouville's theorem, fundamental theorem of algebra, Cauchy's estimate.

References

1. *Complex Analysis* : L.V. Ahlfors
2. *Functions of One Complex Variable* : John B.Conway
3. *Complex Analysis* :T.O.Moore &E.H.Hadlock
4. *Complex Analysis* : Serge Lang
5. *Foundation of Complex Variables* : Ponnuswamy
6. *Complex Analysis* : I. Steward & D. Tall .

Course-MSM 1.5: DISCRETE MATHEMATICS

(Max marks: 100=80+20. Credits: 04)

UNIT-1: Lattice Theory: Partially ordered sets, Lattice, Distributive Lattice, Complements, Demorgan's Laws.

UNIT-2: Boolean Algebra: Boolean Lattice, Finite Boolean lattice, Boolean Expression and function, Conjunctive and disjunctive normal forms.

UNIT-3: Number theory: Introduction, Divisibility, Greatest common, prime numbers, The fundamental theorem of Arithmetic, The series of reciprocals of the primes, The Euclidean algorithm, The greatest common divisor of more than two numbers.

UNIT-4: Congruence: Definition and basic properties of congruences, Residue classes and complete residue systems, Linear congruences, Reduced residue systems and the Euler-Fermat theorem.

UNIT-5: Introduction to 'C': Development of C, Features, Constants and Variables, Data types, Operators and Expressions, Library functions.

UNIT-6: I/O Statements:Formatted and Unformatted I/O, scanf(), printf(), getchar() and putchar() functions.

UNIT-7: Control Structures: Conditional and Unconditional, If, For, While and do-while, Switch, Break and Continue, Goto statement.

UNIT-8: Arrays and functions: One and Multi dimensional arrays, Strings and String functions, Definition and declaration of a function, Different types, Calling a function, Passing parameters, Local and Global variables, Recursive functions.

Reference

1. *C Programming* :Schaum Series
2. *Spirit of C* :Mullish& Cooper
3. *Let us C* :YeswantKanetkar
4. *Introduction to computers and C-programming-* :P.B.Kottor:
5. *General Lattice theory* :Birkhauser.
6. *Discrete Mathematics* :Purna Chandra Biswal.

SECOND SEMESTER

Course-MSM 2.1: LINEAR ALGEBRA (Max marks: 100=80+20. Credits: 06)

UNIT-1: Vector spaces: Definition and example, linear dependence and independence, Basis, dimension, subspaces, homomorphism, isomorphism, Hom(V, W) as a vector space, dual spaces.

UNIT-2: Inner Product Spaces: Annihilator, Schwarz inequality, orthonormal basis, Gram-Schmidt orthogonalization process, orthogonal complement.

UNIT-3: Linear Transformations: The algebra of Linear Transformation, singular and non singular transformations, characteristic polynomials, minimal polynomials, Rank and Nullity, Eigen values and eigen vectors.

UNIT-4: Matrix of Linear Transformation: Examples, matrix of change of basis, similar matrices.

UNIT-5: Canonical Forms: Similar transformations, Invariant subspaces, Triangular forms, Nilpotent Transformations, Jordan form, Trace and Transpose, Determinants.

UNIT-6: Hermitian adjoint: Hermitian transformations, Unitary and Normal Transformations, Real quadratic forms: Sylvester's law of Inertia, rank and signature.

References

1. *Topics in Algebra*: ISBN-9971-512-53-X : I.N.Herstein
2. *Linear Algebra with Applications* : Otto Bretscher.
3. *Linear Algebra* : Surjeet Singh
4. *Finite Dimensional Vector Space* : P.R. Halmos.
5. *Linear Algebra* : Hoffman and Kunze

Course-MSM 2.2: ANALYSIS-II (Max marks: 100=80+20. Credits: 05)

UNIT-1: The Riemann–Steiltje's Integral: Definition and existence of the integral, Properties of the integral, Integration and Differentiation.

UNIT-2: Sequences and Series of Functions: Pointwise and uniform convergence, Uniform convergence& continuity, Uniform convergence & integration, Uniform convergence & differentiation,

UNIT-3: Equicontinuous Families of Functions: Pointwise and uniformly bounded, equicontinuous family of functions, The Stone-Weierstrass theorem.

UNIT-4: Special Functions: Power series, the exponential and Logarithmic functions, the trigonometric functions.

UNIT-5: Functions of Several Variables: Linear transformations, invertible linear operators, matrix representation, Differentiation, partial derivatives, gradients, directional derivative, continuously differentiable functions, The contraction principle.

UNIT-6: The Inverse and Implicit Function Theorem: The Inverse function theorem, Implicit function theorem with examples, Jacobians, Derivatives of Higher order and differentiation of integrals.

References

1. *Principles of Mathematical Analysis* : W. Rudin
2. *Real Analysis* : ISBN-978-81-203-4280-4 : H.L. Royden
3. *Mathematical Analysis* : T.M. Apostal
4. *Real Functions* : C. Goffman
5. *Measure and Integration* : G. De barra
6. *Calculus of variations* : I.M. Geifand & S.V. Famin.

Course-MSM 2.3: PARTIAL DIFFERENTIAL EQUATIONS

(Max marks: 100=80+20. Credits: 06)

UNIT-1: First Order Partial Differential Equations: Introduction, Construction of First- order Partial Differential Equations, Solutions of First Order Partial Differential Equations, Solutions Using Charpit's Method, Method of Cauchy Characteristics, Method of Separation of Variables

UNIT-2: Second Order Partial Differential Equations: Introduction, Origin of Second Order Equations, Equations with Variable Coefficients, Canonical Forms.

UNIT-3: Parabolic Equations: Introduction, Solutions by Separation of Variables, Solutions by Eigenfunction Expansion Method, Solutions by Laplace Transform Method, Solutions by Fourier Transforms Method, Duhamel's Principle, Higher Dimensional Equations, Solutions to parabolic equations in cylindrical and spherical coordinate systems.

UNIT-4: Hyperbolic Equations: Introduction, Method of Characteristics (D'Alembert Solution), Solutions by Separation of Variables, Solutions by Eigen functions Expansion Method, Solutions by Laplace Transform Method, Solutions by Fourier Transform Method, Duhamel's Principle, Solutions to Higher Dimensional Equations, Solutions to hyperbolic equations in cylindrical and spherical coordinate systems.

UNIT-5: Elliptic Equations: Introduction, Solutions by Separation of Variables, Solutions by Eigen functions Expansion Method, Solutions by Fourier Transform Method, Similarity Transformation Method, Solutions to Higher Dimensional Equations, Solutions to ellipticequations in cylindrical and spherical coordinate systems.

References

1. *Nonlinear Partial Differential Equations in Engineering* :Ames, W.F.
2. *Integral Transforms and Their Applications* :Debnath, L
3. *Partial Differential Equations for Scientists and Engineers* : Stanley J. Farlow
4. *Partial Differential Equations of Mathematical Physics* : Tyn Myint-U
5. *Elements of Partial Differential Equations* :I.N. Sneddon
6. *Linear Partial Differential Equations for Scientists and Engineers* : Tyn Myint-U and Lokenath Debnath

Course-MSM 2.4: COMPLEX ANALYSIS-II (Max marks: 100=80+20. Credits: 04)

UNIT-1: Local Properties of Analytic Functions: Isolated and non-isolated singularities, removable singularities, Taylors's theorem, zeros and poles, meromorphic functions, zeros and poles of order 'h', essential singularity, Weierstrass theorem.

UNIT-2: Maximum Modules Principle: The maximum principle, Schwarz lemma, Some applications of Schwarz's lemma, Hadamard's three circles theorem.

UNIT-3: The General Form of Cauchy's Theorem: Chains and cycles, general statement of Cauchy's theorem, locally exact differentials, multiply connected regions.

UNIT-4: Calculus of Residues: Residue at a finite point, residue at the point at infinity, The Residue theorem, The argument principle, Rouche's theorem. Evaluation of the integrals of the type, $\int_{\alpha}^{2\pi+\alpha} R(cos\theta, sin\theta)d\theta$, $\int_{-\infty}^{\infty} f(x)dx$, $\int_{-\infty}^{\infty} g(x)\, cosmxdx$, Cauchy principal value.

UNIT-5: Harmonic Functions: Laplace's equation, The Mean value property, maximum principle for Harmonic functions, Poisson's formula, Schwarz's formula, Schwarz's theorem, The reflection principle.

UNIT-6: Power Series Expansion: Weierstrass's theorem, Hurwitz theorem, the Taylor series, the Laurent series.

UNIT-7: Partial Fractions and Factorization: Partial fractions, infinite products, the gamma function, Stirling's formula.

UNIT-8: Entire Functions: Jensen's formula, Poisson-Jensen formula, Hadamard's theorem.

References

2. *Complex Analysis*: ISBN-0-07-000657-1 : L.V. Ahlfors
3. *Functions of One Complex Variable* : John B.Conway
4. *Complex Analysis* : T.O. Moore & E.H. Hadlock
5. *Complex Analysis* : Serge Lang
6. *Foundation of Complex Variables* : S Ponnuswamy
7. *Complex Analysis* : I. Steward & D. Tall

Course-MSM 2.5: GRAPH THEORY (Max marks: 100=80+20. Credits: 04)

UNIT-1: Introduction to Graph: Basic concept, Different types of graphs, walks and connectedness. Degree sequences, directed graphs, distances and self-complementary graphs.

UNIT-2: Factorization: 1-factorization,2-factorization, decomposition and labeling of graphs,

UNIT-3: Coverings: Vertex covering, edge covering, independence number and matchings and matching polynomials.

UNIT-4: Planarity: Planar graphs, outer planar graphs, Kuratowaski criterion for planarity and Eulers polyhedron formula.

UNIT-5: Graph valued functions: Line graphs, subdivision graph and total graphs.

UNIT-6: Colourings: Chromatic numbers and chromatic polynomials.

UNIT-7: Spectra of Graphs: Adjacency matrix, incidence matrix, characteristic polynomials, Eigen values, graph parameters, strongly regular graphs and Friendship Theorem.

UNIT-8: Groups and Graphs: Automorphism group of a graph, operations on permutation graphs, the group of a composite graph.

References

1. *Graphs and Digraphs* :M. Bejzad, G. Charatrand and L. Leniak-foster.
2. *Graph Theory* : F. Harary.
3. *Graph Theory and Applications*:J.A. Bonday and V. S.R. Murthy.
4. *Graph Theory* :Diestel.
5. *Graph Theory* :R Gould.
6. *Graph Theory with Applications to Engineering &Computer Science*: **:** NaraisingDeo.
7. *Distance in Graphs* : F. Buckley and F. Harary.
8. *Theory of Graphs* : O.Ore
9. *Spectra in Graphs* :D. Cvetkovic.

THIRD SEMESTER

Course-MSM 3.1: MEASURE THEORY AND INTEGRATION

(Max marks:100=80+20. Credits :06)

UNIT-1: Lebesgue Measure: Introduction, Outer measure, measurable sets and Lebesgue measure, translation invariant, algebra of measurable sets, countable subadditivity, countable additively and continuity of measure, Borel sets, a non- measurable set.

UNIT-2: Measurable Function: Examples: Characteristic function, constant function and continuous function, Sums, products and compositions, Sequential point wise limits, Simple functions, Littlewood's three principles,

UNIT-3: Lebesgue Integral of Bounded Functions: The Riemann integral, integral of simple functions, integral of bounded functions over a set of finite measure, bounded convergence theorem.

UNIT-4: The General Lebesgue Integral: Lebesgue integral of measurable nonnegative functions, Fatou's lemma, Monotone convergence theorem, the general Lebesgue integral, integrable functions, linearity and monotonicity of integration, additivity over the domains of integration. Lebesgue dominated convergence theorem.

UNIT-5: Differentiation and Integration: Differentiation of monotone functions, Vitali covering lemma, Dini derivatives, Lebesgue differentiation theorem, functions of bounded variation, Jordan's theorem, differentiation of an integral, indefinite integral, absolute continuity.

UNIT-6: The $\boldsymbol{L^P}$ Spaces: L^p spaces, the Holder and Minkowski inequalities, convergence and completeness, bounded linear functions on the L^p spaces.

References

1. *Real Analysis:* ISBN-978-81-203-4280-4 : H.L.Royden
2. *Measure Theory & Integration* : De Barra
3. *Measure Theory* : P.R. Halmos

Course-MSM 3.2: TOPOLOGY-I (Max marks: 100=80+20. Credits: 05)

UNIT-1: Set Theory and Logic: Revive of Basic concept, Cartesian product, principles of recurrence relations, well order set, maximum principles.

UNIT-2: Topological Spaces: Basic topological spaces, Topological spaces: The definition and examples, Bases for a topology, Open sets and closed sets; Interior closure of a set, Exterior and boundary, Relative or subspace topology; sub bases.

UNIT-3: Continuity and convergence: Hausdorff spaces, continuous function, open and closed maps, Pasting Lemma, convergence, uniform convergence theorem, Homeomorphism, maps into products.

UNIT-4: Product topology: Order topology, product topology, The weak topology and the product topology, The uniform Metric, Quotient space, metric topology, examples for nonmetrizable spaces.

UNIT-5: Connectedness: Connected spaces, path connected spaces; various counter examples, Connected subspaces of Real line, Components and path components; locally connected and locally path connected spaces, totally disconnected spaces.

UNIT-6: Compactness: Converging properties, Lindelof spaces, Basic properties of Lindeloff compact spaces, Compact subspaces of the real line, Extreme value theorem, Uniform continuity theorem, Countable compactness; Sequential compactness, limit point compactness; Bolzano-Weierstrass property, Compactness in metric spaces; Tychnoffs theorem.

References

1. *A First Course in Topology*: ISBN-81-203-2046-8 : J.R. Munkres
2. *Topology* : J.Dugundji
3. *General Topology* : S. Willard
3. *Algebraic Topology, A First Course* : M.J.Greenberg.

Course-MSM 3.3: NUMERICAL ANALYSIS-I (Max marks: 100=80+20. Credits: 05)

UNIT-1: Solutions of Linear System of Equations: Introduction to Direct Methods via., Gauss Elimination method, Gauss-Jordan method, LU factorization, Triangularisation method, Iteration Methods: Gauss Jordan methods, Gauss-Seidel method, Successive Over relaxation method, Convergence Criteria, and problems on each methods.

UNIT-2: Solutions of Nonlinear/Transcendental Equations: Fixed point iteration, Method of Falsi position, Newton Raphson Method, Secant method, Regula-Falsi Method, Muller's Method, Aitken's Δ^2 method, Orders of convergence of each methods. Problems on each methods. Origin of roots by Sturm Sequences. Extraction of quadratic polynomial by Bairstow's method.

UNIT-3: Eigenvalues and Eigenvectors Of A Matrix: The characteristics of a polynomial, The eigenvalues and eigenvectors of matrix by Jocobi's method, Given's method, House holders method, power method, Inverse Power method, QR Algorithm.

UNIT-4: Interpolation Theory: Polynomial interpolation theory, Gregory Newtons forward, back ward and Central difference interpolation polynomial. Lagranges interpolation polynomial, truncation error. Hermite interpolation polynomial, Inverse interpolation, Piece wise polynomial interpolation, Trigonometric interpolation, Convergence Analysis,

UNIT-5: Approximation Theory: Introduction, Spline approximation, Cubic splines, Best approximation property, Least square approximation for both discrete data and for continuous functions, Reme's single and multiple exchange algorithm. Problems on each.

References

1. *A First Course in Numerical Analysis* : A. Ralston
2. *Numerical Analysis & Computation* : E.K. Blum
3. *Elements of Numerical Analysis* : P. Henrici
4. *Introduction to Numerical Analysis* : F.R. Hindebrand
5. *Principles & Procedures of Numerical Analysis* : F. Szidarovszky& S. Yakowitz.

Course-MSM-3.4: DIFFERENTIAL GEOMETRY

(Max marks: 100=80+20. Credits: 04)

UNIT-1: Curves and Surfaces -An Introduction: What is Curve? Parametrized curve, Level curves, Curvature, Plane curves, Space curves. What is Surface? Smooth surfaces, Examples of Surface.

UNIT-2: Calculus on Euclidean Space: Euclidean space, Tangent Vectors, Vector field, Directional derivatives, Curves in R^3.

UNIT-3: Differential Forms: 1-Forms, Differential forms, Mappings on Euclidean spaces, Derivative map, Dot product on R^3, Dot product of tangent vectors, Frame at a point.

UNIT-4: Surfaces in R^3: Calculus on a Surface, Cross product of tangent vectors, Curves in R^3, Arc length, Reparametrization, The Frenet formulas, Frenet frame field, Curvature and Torsion of a unit speed curve.

UNIT-5: Frame Fields: Arbitrary speed curves, Frenet formulas for arbitrary speed curve, Covariant derivatives, Frame field on R^3, Connection forms of a frame field, Cartan's structural equations.

UNIT-6: Calculus on a Surface: Calculus on a Surface, Co-ordinate patch, Proper patch, Surface in R^3, Monge Patch, Patch computations, Parameterization of a cylinder, Differentiable functions and tangent vectors, Tangent of a Surface, Tangent plane, Vector field, Tangent and Normal Vector field on a Surface.

UNIT-7: The First and Second Fundamental Form: First fundamental form, Length of curves on Surfaces, Isometries of Surfaces, Conformal mappings of surfaces.

Second fundamental form, The Curvature of curves on a surfaces with examples.

UNIT-8: Shape operators: Definition of Shape Operator, Normal curvature, Gaussian curvature, Computational techniques, Special curves in Surfaces.

References

1. *Elementary Differential Geometry* : Andrew Pressly
2. *Elementary Differential Geometry* : Barret O'Neil.
3. *An introduction to Differential Geometry* : T.J. Willmore
4. *Differential Geometry – An Integrated approach* : Nirmala Prakash

5. *An Introduction to Differential Manifolds* : Y. Matsushima.

Course-MSM 3.5: FLUID MECHANICS (Max marks: 100=80+20. Credits: 04)

UNIT-1: Motion of Inviscid Fluids: Pressure at a point in a fluid at rest and that in motion, Euler's equation on motion, Barotropic flows, Bernoullis equations in standard forms, Illustrative examples thereon, Vortex motion, Circulation, Kelvin's circulation theorem, HelmhotzVorticity equation, Performance in Vorticity and Circulation, Kelvin's Minimum Energy Theorem, Illustrative examples.

UNIT-2: Two Dimensional Flows of Inviscid Fluids: Meaning of two dimensional flows and Examples, Stream function, Complex potential, Line Sources and Line Sinks, Line Doublets and Line Vortices, Milne Thomson circle theorem and Applications, Blasius theorem and Applications.

UNIT-3: Motion of Viscous Fluids: Stress tensor of viscous fluid flow, Stoke's law, Navierstoke's equation, Simple exact solutions of the Navier-Stoke's equation, Standard applications, i) Plane Poiseuille and Hagen Poiscuileflows ii)Couette flow iii) Steady flow between concentric cylinders iv) Beltrami flows v) Unsteady flow near an oscillating plate vi) Slow and steady flow past a rigid sphere and cylinder. Diffusion of Vorticity, Energy dissipation due to Viscosity, Dimensional analysis (Brief discussion), Reynolds number, Laminar and Turbulent flows, Examples of flow at low and high Reynolds number, Brief discussion of boundary layer theory with illustrative examples.

UNIT-4: Gas Dynamics: Compressible fluid flows, Standard forms of equations of State,Speed of sound in a gas, Equations of motion of Non-Viscous and Viscous Compressible flows, Subsonic, Sonic and supersonic flows, Isentropic flows, Gas Dynamical Equations, Illustrative examples.

References

1. *Fluid Dynamics* : F. Chorlton
2. *Theoretical Hydrodynamics* : L.M. Milne-Thomson
3. *Foundations of Fluid Mechanics* : S.W. Yuan
4. *Continuum Mechanics* : D.S. Chandrashekharaiah&L.Debnath.

FOURTH SEMESTER

Course-MSM 4.1: FUNCTIONAL ANALYSIS

(Max marks: 100=80+20. Credits: 06)

UNIT-1: Normed linear spaces and Banach Spaces: Normed linear spaces, Banach spaces, definition with examples, quotient spaces, Bounded linear transformation. equivalent form of continuity and boundedness.

UNIT-2: Isometric isomorphism: Topological isomorphism, operators, equivalent norms, Reisz lemma.

UNIT-3: Functional conjugate spaces: Functional, conjugate space, extension of functional, Hahn-Banach theorem and its consequences, natural imbedding, induced functional, open mapping theorem, closed graph theorem, Uniform boundedness principle.

UNIT-4: Hilbert spaces: Definition and examples, Inner product, Schwarz inequality, parallelogram law and polarization identity, orthogonal complements, Pythagorean theorem, Orthonormal sets, Bessel's inequality.

UNIT-5: Conjugate Space $\boldsymbol{H}^*$: Reisz representation theorem. The adjoint of an operator, self-adjoint operators, normal and unitary operators,

UNIT-6: Projections: Range space and null space, perpendicular projections, finite dimensional spectral theory.

References

1. *Introduction to Topology & Modern Analysis* : G.F.Simmons
2. *First Course in Functional Analysis* : Goffman &Pedrick
3. *Introduction to Functional Analysis* : A.E. Taylor & D.C. Lay
4. *Functional Analysis* : Walter Rudin.

Course-MSM 4.2: TOPOLOGY-II (Max marks: 100=75+25. Credits: 05)

UNIT-1: Countablity and Separation axioms : First and second countable spaces, sperable and Lindeloff spaces and examples. T_0,$T_1$and T_2 spaces, Hausdorff, Regular and completely regular spaces, normal and completely normal spaces; Complete and collection wise normal spaces; The countability axioms, Local compactness.

UNIT-2: Uryshon's Theorem: Uryshon's lemma, Tietze's extension theorem, Uryshon's metrization theorem.

UNIT-3: Tychonoff Theorem: Tychonoff theorem, the Stone- Cech compactification: compactification, equivalence.

UNIT-4: Paracompactness: Local finiteness, refinement, Nagata-Smirnov metrization theorem, paracampactness and paracompact spaces.

UNIT-5: Homotopy: Homotopy, product of path homotopy, the fundamental Group, simply connected spaces.

UNIT-6: Covering Space: Slices, covering map, local homeomorphism, the fundamental group of circles, lifting.

References

1. *Topology* (2nd Edition) : J.R. Munkres
2. *Algebraic Topology* : M.J. Greenberg and J. Harper
3. *Algebraic Topology: An Introduction* : W.S. Massey.

Course-MSM 4.3: NUMERICAL ANALYSIS-II

(Max marks: 100=80+20. Credits: 05)

UNIT-I: Numerical Differentiation and Integration: Introduction, errors in numerical differentiation, Extrapolation methods, cubic spline method, differentiation formulae with function values, maximum and minimum values of a tabulated function, partial differentiation. Numerical Integration, Newton-Cotes integration methods; Trapezoidal rule, Simpson's 1\3rd rule, Simpson's 3\8th rule and Weddle's rule. Gaussian integration methods and their error analysis. Gauss-Legendre, Gauss-Hermite, Gauss-Legurre and Gauss-Chebyshev integration methods and their error analysis. Romberg integration, Double integration.

UNIT-2: Numerical Solutions of Initial Value Problems (Ordinary Differential Equations): Introduction, Derivation of Taylor's series method, Euler's method, Modified Euler Method, Runge-Kutta Second, Third and Forth order methods, Runge- Kutta-Gill method, Predictor-Corrector methods; Milne's method, Adam's Bashforth Moulton method.

UNIT-3: Solutions of Boundary Value Problems (Ordinary Differential Equations): Introduction, Solution of boundary value problems method of undetermined coefficients, Finite difference methods, Shooting Method, and Midpoint method.

UNIT-4:Numerical Solutions of Partial Differential Equations: Introduction, Derivation of finite difference approximations to the derivatives, Solution of Laplace equation by Jacobi, Gauss Seidel and SOR Methods, ADI Method, Parabolic, Solution of heat equation by Schmidt and Crank-Nicolson Methods, Solution of wave equation using Finite difference method.

UNIT-5: Numerical Solutions of Integral Equations: Introduction, Numerical methods for Fredholm equations; method of degenerate kernel's, method of successive approximations, quadrature methods, Cubic spline method.

References

1. *A First Course in Numerical Analysis* : A. Ralston
2. *Numerical Analysis & Computation* : E.K. Blum
3. *Elements of Numerical Analysis* : P. Henrici
4. *Introduction to Numerical Analysis* : F.R. Hindebrand
5. *Principles & Procedures of Numerical Analysis* : F. Szidarovszky & S. Yakowitz.

Course-MSM 4.4: RIEMANNIAN GEOMETRY

(Max marks: 100=80+20. Credits: 04)

UNIT-1: Introduction to Manifolds: Preliminary comments on R^n, R^n and Euclidean space, Toplogical Manifolds with examples. Further examples of Manifolds: Cutting and pasting. Abstrac Manifold some examples.

UNIT-2: Differentiable Manifolds: Definition of Differentiable Manifolds, Examples of Differentiable Manifolds, Differentiable (smooth) functions, Local coordinate system, Differentiable Mappings, Tangent vectors and Tangent spaces, vector fields, Jacobian of derivative map. Lie bracket. Immersion and Imbedding of Manifolds, submanifolds.

UNIT-3: Riemannian Manifolds: Riemannian metric, Riemannian manifold and maps, Riemannian manifold as metric space, Groups and Riemannian manifolds, Local representation of metrics. Connections, the connections in local coordinates, Riemannian connections.

UNIT-4: Curvature: Curvature, fundamental curvature equations: Gauss and Codazzi-Mainardi Equations; Tangential curvature equation, Normal or Mixed curvature equations, some Tensor concepts, Riemannian curvature, Riemannian Christoffel curvature tensors and sectional curvature. Fundamental theorem of Riemannian Geometry.

UNIT-5: Hypersurface: Gauss Map, Weingarten map, Existence of Hypersurface, Fundamental theorem of Hypersurface theory and Gauss Bonnet Theorem.

UNIT-6: Geodesics: Partials, Mixed partials, Geodesics, Metric structure of Riemannian Manifold, Gauss Lemma. Why short Geodesics are segments?

References

1. *An introduction to Differential Geometry* : Barret O'Neil.
2. *An Introduction to Differential Manifolds* : N.J. Hicks
3. *An Introduction to Differential Manifolds* : Y. Matsushima
4. *An Introduction to Differential Manifolds* : Nirmala Prakash
5. *An Introduction t Differential Manifolds and Reimannian Geometry*: : W.M. Boothby.

6. Riemannian Geometry : Peter Petersen.

Course-MSM 4.5 MAGNETOHYDRODYNAMICS

(Max marks: 100=80+20. Credits: 04)

UNIT-1: Electrodynamics: Outline of electromagnetic units and Electrostatics, Derivations of Gauss Law, Faraday's Law, Ampere's Law and Solenoidal property, Dielectric material, Conservation of charges, Electromagnetic boundary conditions.

UNIT-2: Basic Equations: Outline of Basic equations of MHD, Magnetic Induction equation, Lorentz force, MHD approximations, Non-dimensional numbers, Velocity, Temperature and Magnetic field boundary conditions.

UNIT-3: Exact Solutions: Hartmann flow, isothermal boundary conditions, Temperature distribution in Hartmann flow, Hartmann-Couette flow.

UNIT-4: Applications: Concepts in Magneto statics, Classical MHD and Alfven waves, Alfven theorem, Frozen-n-phenomena and equipartition of energy by Alfven waves.

References

2. *An Introduction to Magneto fluid Mechanics* :V.C.A. Ferraro and Plumpton.

3. *An Introduction to Magneto hydrodynamics* : P.H. Roberts

4. *Magneto hydrodynamics* : Allen Jeffrey.

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