KARNATAK UNIVERSITY, DHARWAD
ACADEMIC (S&T) SECTION

ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಧಾರವಾಡ
ವಿದ್ಯಾಮಂಡಳ (ಎಸ್&ಟಿ) ವಿಭಾಗ

ಸ್ವಾತಂತ್ರ್ಯದ ಅಮೃತ ಮಹೋತ್ಸವ

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NAAC Accredited
'A' Grade 2014

No. KU/Aca(S&T)/JS/MGJ(Gen)/2024-25/436 Date: 11 NOV 2024

ಅಧಿಸೂಚನೆ

ವಿಷಯ: ರಾಷ್ಟ್ರೀಯ ಶಿಕ್ಷಣ ನೀತಿಯನುಸಾರ 2024–25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ಪದವಿಗಳಿಗೆ / ಸ್ನಾತಕೋತ್ತರ ಡಿಪ್ಲೋಮಾಗಳಿಗೆ ಪಠ್ಯಕ್ರಮವನ್ನು ಪ್ರಕಟಣೆ ಕುರಿತು.

ಉಲ್ಲೇಖ: 1. ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ನಿರ್ಣಯ ಸಂಖ್ಯೆ: 2 ರಿಂದ 9, ದಿ: 08.11.2024.
2. ಮಾನ್ಯ ಕುಲಪತಿಗಳ ಅನುಮೋದನೆ ದಿನಾಂಕ: 11.11.2024.

ರಾಷ್ಟ್ರೀಯ ಶಿಕ್ಷಣ ನೀತಿಯನುಸಾರ 2024–25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಅನ್ವಯವಾಗುವಂತೆ, ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯದ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ಪದವಿಗಳಾದ M.A./ M.Sc / M.Com / MBA / M.Ed 1 ರಿಂದ 4ನೇ ಸೆಮೆಸ್ಟರ್‌ಗಳಿಗೆ ಮತ್ತು 1 & 2ನೇ ಸೆಮೆಸ್ಟರ್‌ಗಳ ಸ್ನಾತಕೋತ್ತರ ಡಿಪ್ಲೋಮಾಗಳಿಗೆ ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ಅನುಮೋದನೆಯೊಂದಿಗೆ ಈ ಕೆಳಗಿನಂತೆ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಅಳವಡಿಸಿಕೊಳ್ಳಲಾಗಿದೆ. ಕಾರಣ, ಸಂಬಂಧಪಟ್ಟ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ವಿಭಾಗಗಳ ಅಧ್ಯಕ್ಷರು / ಸಂಯೋಜಕರು / ಆಡಳಿತಾಧಿಕಾರಿಗಳು / ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳು / ಶಿಕ್ಷಕರು ಸದರಿ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಅನುಸರಿಸುವುದು ಮತ್ತು ಸದರಿ ಪಠ್ಯಕ್ರಮವನ್ನು ಕ.ವಿ.ವಿ. ಅಂತರ್ಜಾಲ www.kud.ac.in ದಲ್ಲಿ ಭಿತ್ತರಿಸಲಾಗಿದನ್ನು ಸಂಬಂಧಪಟ್ಟ ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ ಸೂಚಿಸುವುದು.

Arts Faculty

Sl.No	Programmes	Sl.No	Programmes
1	Kannada	8	MVA in Applied Art
2	English	9	French
3	Folklore	10	Urdu
4	Linguistics	11	Persian
5	Hindi	12	Sanskrit
6	Marathi	13	MPA Music
7	MVA in Painting		

Faculty of Science & Technology

Sl.No	Programmes	Sl.No	Programmes
1	Geography	10	M.Sc (CS)
2	Chemistry	11	MCA
3	Statistics	12	Marine Biology
4	Applied Geology	13	Criminology & Forensic Science
5	Biochemistry	14	Mathematics
6	Biotechnology	15	Psychology
7	Microbiology	16	Applied Genetics
8	Zoology	17	Physics
9	Botany	18	Anthropology

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Faculty of Social Science

Sl.No	Programmes	Sl.No	Programmes
1	Political Science	8	Journalism m & Mass Commn.
2	Public Administration	9	M.Lib. Information Science
3	History & Archaeology	10	Philosophy
4	A.I.History & Epigraphy	11	Yoga Studies
5	Economics	12	MTTM
6	Sociology	13	Women's Studies
7	MSW		

Management Faculty

Sl.No	Programmes	Sl.No	Programmes
1	MBA	2	MBA (Evening)

Faculty of Commerce

Sl.No	Programmes	Sl.No	Programmes
1	M.Com	2	M.Com (CS)

Faculty of Education

Sl.No	Programmes	Sl.No	Programmes
1	M.Ed	2	M.P.Ed

OEC subject for PG

Sl.No	Programmes	Sl.No	Programmes
1	Russian	5	Veman Peetha
2	Kanaka Studies	6	Ambedkar Studies
3	Jainology	7	Chatrapati Shahu Maharaj Studies
4	Babu Jagajivan Ram	8	Vivekanand Studies

PG Diploma

Sl.No	Programmes	Sl.No	Programmes
1	PG Diploma in Chatrapati Shahu Maharaj Studies	2	P.G. Diploma in Women's Studies
3	P.G. Diploma in Entrepreneurial Finance		

ಅಡಕ: ಮೇಲಿನಂತೆ

ಕುಲಸಚಿವರು.

ಗೆ,

1. ಕ.ವಿ.ವಿ. ಸ್ನಾತಕೋತ್ತರ ಅಧ್ಯಕ್ಷರುಗಳಿಗೆ / ಸಂಯೋಜಕರುಗಳಿಗೆ / ಆಡಳಿತಾಧಿಕಾರಿಗಳಿಗೆ / ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳಿಗೆ
2. ಎಲ್ಲ ನಿಖಾಯದ ಡೀನರು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.

ಪ್ರತಿ:

1. ಕುಲಪತಿಗಳ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
2. ಕುಲಸಚಿವರ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
3. ಕುಲಸಚಿವರು (ಮೌಲ್ಯಮಾಪನ) ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
4. ಅಧೀಕ್ಷಕರು, ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆ / ಗೌಪ್ಯ / ಜಿ.ಎ.ಡಿ. / ವಿದ್ಯಾಂಡಳ (ಪಿ.ಜಿ.ಪಿಎಚ್.ಡಿ) ವಿಭಾಗ/ ಸಿಸ್ಟಮ್ ಅನಾಲೆಸಿಸ್ಟ್ / ಸಂಬಂಧಿಸಿದ ಪದವಿಗಳ ವಿಭಾಗಗಳು, ಪರೀಕ್ಷಾ ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
5. ನಿರ್ದೇಶಕರು, ಕಾಲೇಜು ಅಭಿವೃದ್ಧಿ / ವಿದ್ಯಾರ್ಥಿ ಕಲ್ಯಾಣ ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
6. ನಿರ್ದೇಶಕರು, ಐ.ಟಿ. ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ ಇವರಿಗೆ ಕ.ವಿ.ವಿ. ಅಂತರ್ಜಾಲದಲ್ಲಿ ಪ್ರಕಟಿಸುವುದು.

KARNATAK UNIVERSITY DHARWAD

Faculty of Science and Technology

Two Years PG Programme
M.Sc. MATHEMATICS

Programme Structure and Syllabus
As per NEP-2020

DISCIPLINE SPECIFIC CORE COURSE (DSC) FOR SEM I – IV
DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE) FOR SEM III & IV
OPEN ELECTIVE COURSE (OEC) FOR SEM II AND III

With effect from 2024-25

About Karnatak University Dharwad: Karnatak University, DharwadisthesecondoldestUniversityinthestateofKarnataka,established in theyear1949.TheUniversityisspreadover 888Acresof landandthecampusisknownasPavateNagar, namedafter Wrangler Dr. D. C. Pavate, who was an educationaladministrator and former Vice-Chancellor of KarnatakUniversity Dharwad. The University is presently re-accredited withthe ‘A’ Grade status by the NAAC in 2022 and awardedUniversity with Potential for Excellence by University Grants Commission.

About the Mathematics Department: The Department of Mathematics was established in the year 1958. Since then, the Department is serving as seat of learning and research imparting higher education in Mathematics. The Department offers M.Sc., and Ph.D. Degrees in Mathematics. Presently active research is being carried out in the areas of Graph Theory, Topology, Wavelet Analysis, Complex Analysis, Fluid Dynamics, Functional Analysis, Differential Equations, Numerical Analysis, Algebra, Real Analysis, Operations Research, Linear Algebra, Integral Transforms and Integral Equations, Calculus of Variations etc. Department has successfully completed UGC-SAP DRS-III and DST-FIST. Presently the Department is supported by the NBHM Library Grants. Active P. G. Programme is being carried out in the Department with the title of M.Sc. (MATHEMATICS), with a curriculum structure with effect from 2024-25 with the Discipline Specific Core Course (DSC) for Sem I – IV, Discipline Specific Elective Course (DSE) for Sem III & IV and Open Elective Course (OEC) for Sem II & III. Type of Course and Course Titles are as follows: DSC – 1: Algebra, DSC – 2: Real Analysis, DSC – 3: Complex Analysis – I, DSC – 4: Topology – I, DSC – 5: Operations Research, DSC – 6: C-Programming Lab, DSC – 7: Linear Algebra, DSC – 8: Complex Analysis – II, DSC – 9: Topology – II, DSC – 10: Ordinary Differential Equations, OEC – 1: Discrete Mathematical Structures and Differential Calculus, DSC – 11: MATLAB - Programming Lab, DSC – 12: Partial Differential Equations and Numerical Methods, DSC – 13: Measure Theory and Integration, DSC – 14: Fluid Mechanics, DSE – 1(A): Nevanlinna Theory, DSE – 1(B): Discrete Mathematical Structures, DSE – 1(C): Number Theory, OEC – 2: Fuzzy Sets and Numerical Methods, DSC – 15: MAPLE- Programming Lab, DSC – 16: Functional Analysis, DSC – 17: Fuzzy Topology, DSC – 18: Wavelet Theory, DSE – 2(A): Graph Theory, DSE – 2(B): Differential Geometry, DSE – 2(C): Classical Mechanics, DSC – 19: MATHEMATICA - Programming Lab, DSC – 20: Project Work.

Brief Profile of the Mathematics Department: Wrangler Dr. D. C. Pavate, an alumnus of Sidney Sussex College Cambridge, a visionary Educationist, focused with deep interest in making Karnatak University Dharwad an ideal centre of higher learning. His founding vision was based on a reflection of what eminent academicians have been beguiled and entranced by the profound quintessence of Mathematics. Towards this goal Wrangler Dr. D. C. Pavate put maximum effort and used his unique contacts to attract world famous Mathematicians for the faculty position which he could accomplish with all pleasure. He invited the most famous Indian Mathematician Prof. C. N. Srinivas Iyengar (1958-1963) to head the Department along with Prof. P. N. Shivakumar (1958-1966) an almnus of London University, Prof. S. K. Singh(1961-1968) close associate of world famous Mathematicians, andProf. S. M. Shah of US. Later, Prof. K. Sundareshan (1961-1962), Prof. Sanatani (1966-1967) both from US joined them. They were there for a short tenure but have leftlasting profound academic flavour on the rest of the faculty who joined Department later.

Prof. H. S. Gopalakrishna (1961-1982), Prof. K. S. Amur ((1962-1992), who was later Full bright Fellow at Purdue, also served as Registrar, KUD), Prof. E. Sampathkumar (1964-1989), Prof. S. R. Malghan ((1967-1992), Ph.D (Michigun)), Prof. S. M. Sarangi ((1968-1998), Ph.D(Kansas, USA)) had big responsibility of maintaining the legacy of the great foundation by introducing relevant courses and keeping abreast of the progress in Mathematics.

Prof. N. M. Bujurke (1983-2004), FNA,FNASc., INSA Senior Scientist. Commonwealth Academic Staff Fellow at DAMTP Cambridge, a Fellow of INSA a rare honour, with his active collaboration with eminent Mathematicians from IIT (Delhi), IISC (Bangalore) and DAMTP (Cambridge) took a timely responsibility in leading with all academic flavour of Mathematics to much higher level. He along with other colleagues is responsible for introducing very important courses like, PGDCA, MCA, M.Sc. (CS) and Computer Science Programming Lab Courses for M.Sc. Mathematics. This enabled to have computer culture in the University and slowly spread to entire Northern Karnataka. As these courses introduced much earlier (1984) in Karnatak University Dharwad and as such Karnatak University Dharwad had a unique position. Prof. N. M. Bujurke, served asChairman (1984-2004), Department of Computer Science, Karnatak University Dharwad, with the active support of colleagues sustained such an important academic activity for a long time (1984-2004).This is the solid devoted contribution of Department of Mathematics.

Prof. H. B. Walikar (1989-2007), a Sr. Professor, served as Vice Chancellor of Karnatak University Dharwad (2010-2014) and worked hard for the progress as Departmentsof the University. During his tenure the University is accredited withthe 'A' Grade status by the NAAC and awarded University with Potential for Excellence by University Grants Commission. He has also served as Administrator (1998-2000), Karnatak University's PG Center, Belgaum,Nodal Officer (2008-2010), E-Governance Karnatak University Dharwad, President (2008-2009), Post Graduate Gymkhana, Karnatak University Dharwad, Chairman (2010-2014), Department of Computer Science,Karnatak University Dharwad.

Later Department had other famous academicians Prof. B. A. Uralegaddi (1968-1998), Prof. S. B. Ghokale (1968-1972), Prof. V. N. Kulkarni (1968-1983), Prof. Smt. P. S. Neeralagi (1968-2002), Dr. G. R. Hiremath ((1968-1981), Ph.D (Pittsburgh)), Prof. Smt. Nirmala Agashe (1972-1974), Prof. D. J. Shetty (1976-1983), Prof. P. S. Hiremath (1986-1992), Prof. S. S. Bhoosnurmath (1985-2007), Prof. V. A. Hiremath (1989-2009), Prof. S. N. Gaikwad (2012-2012), Prof. S. S. Benchalli (1986-2016), Dr. Smt. S. C. P. Halakatti (1985-2019), Prof. D. G. Prakasha(2009-2019), Dr. Kumbinarasaiah S., (2014-2020), Prof. P. M. Patil (2013-2022), Prof. B. Basavanagoud (1996-2024), who have helped the Department of Mathematics to maintain the required standard.

Prof. P. M. Patil (2013-2022),a recipient of the prestigious Commonwealth Academic Fellowship(2011-2012), awarded by Commonwealth Scholarship Commission, London and British Council, United Kingdom and worked with Dr. D. Andrew S. Rees, Department of Mechanical Engineering, University of Bath, United Kingdom. He is a Fellow of National Academy of Sciences (FNASc.), Prayagraj (Allahabad) (2019) and a Fellow of Karnataka Science and Technology Academy (FKSTA), Bengaluru (2021). He is a Visiting Professor in the Department of Mathematics and Applied Mathematics, Faculty of Science, University of Johannesburg, South Africa (2019-2022 & 2022-2025).

Mathematics Department Faculty's, Prof. S. S. Benchalli, served as Chairman (2004-2010), Department of Computer Science, Karnatak University Dharwad,He has also served as Dean Faculty of Science and Technology, Syndicate and Academic Council Member, Karnatak University Dharwad (2014-2016). Prof. B. Basavanagoud, served as Dean Faculty of Science and Technology, Syndicate and Academic Council Member, Karnatak University Dharwad (2021-2023).Prof. P. M. Patil, served asPresident (2020-2022),Post Graduate Gymkhana, Karnatak University Dharwad.Prof.

P. G. Patil, served asVice President (Sports) (2020-2022), Post Graduate Gymkhana, Karnatak University Dharwad.Prof. S. C. Shiralashetti, served asPresident (2022-2023),Post Graduate Gymkhana, Karnatak University Dharwad andProf. H. S. Ramane, served as Vice President (Sports) (2022-2023), Post Graduate Gymkhana, Karnatak University Dharwad,

Prof. P. G. Patil, served as a Special Officer Challenge valuation, exam section, KUD,who have helped the University to maintain the required standard, this is the honour and solid contribution of Department of Mathematics.

Department of Mathematics is quite active in organizing National and International Seminars / Symposium / Conferences / Special Lectures / Workshops / Collaborative Research Activities / etc. Mathematics Department staff members and students are actively participating in the extra-curricular activities of the University and other National and International Institutions. Department Faculty Members and Research Scholars are regularly participating and presenting their research papers in the National and International Conferencesin India and Abroad. Also, they are all publishing their Research Articles in the referred and reputed National and International Journals. So far, Department has guided more than 230 students forPh.D., who are working at various prestigious Institutions in India and Abroad. Department Faculty Members, Research Scholars and M.Sc. Students are regularly receiving Awards and Honours in research and extra-curricular activities from University and other National and International Institutions.

Mathematics Department Faculty Members have received Best Research Publications in Science Awards from Karnatak University Dharwad, they are, Prof. P. M. Patil, three times (2018, 2019 & 2020),Prof. H. S. Ramane, two times (2017&2022), Prof. S. C. Shiralashetti, four times (2016, 2017, 2019 & 2021), Prof. D. G. Prakasha, three times (2016, 2017 & 2018),Dr. Asha. S. K., two times (2020 & 2022). Allthese Awards have tremendous research contributions to the Mathematics Department.

In testimony of the teaching and research, Department of Mathematics received timely financial support from UGC-SAP, DST, AICTE, NBHM, etc. to sustain / maintain the standard expected by a University. Department had eminent academicians as visitors for giving Special Lectures and interacting with Teachers, Research Scholars and M.Sc. Students.

Prof. T. J. Pedley. FRS, DAMTP, University of Cambridge, visited Karnatak University Dharwad when he was a Professor and Head at University of Leeds.He was distinguished G. I. Taylor Professor at DAMTP, University of Cambridge and he was a Raman Professor at IASc., Bangalore.

The rotation among the Chairman's of the Department was witnessed from 1958 with (1) Dr. C. N. Srinivas Iyengar, D.Sc. (1958-1963). (2) Dr. S. K. Singh, M.A., Ph.D. (1963-1968). (3) Dr. K. S. Amur, M.Sc., Ph.D. (1968-1983, 1984-1985 & 1991-1992). (4) Dr. E. Sampathkumar, M.Sc., Ph.D. (1983-1984 & 1985-1987). (5) Dr. S. M. Sarangi, M.Sc., M.A., Ph.D. (1987-1989 & 1992-1993). (6) Dr. S. R. Malghan, M.A., Ph.D. (1989-1991). (7) Dr. N. M. Bujurke, M.Sc., Ph.D. (1993-1995 & 2002-2004). (8) Dr. B. A. Uralegaddi, M.Sc., Ph.D. (1995-1997). (9) Dr. (Mrs). Prabha. S. Neeralagi, M.A., Ph.D. (1997-1999). (10) Dr. S. S. Bhoosnurmath, M.Sc., Ph.D. (1999-2001 & 2004-2006). (11) Dr. V. A. Hiremath, M.Sc., Ph.D. (2001-2002 & 2006-2008). (12) Dr. S. S. Benchalli, M.Sc., Ph.D. (2008-2010 & 2014-2016). (13) Dr. B. Basavangoud, M.Sc., Ph.D. (2010-2012 & 2016-2018). (14) Dr. (Smt). S. C. P. Halakatti, M.Sc., Ph.D. (2012-2014). (15) Dr. H. S. Ramane, M.Sc., Ph.D. (2014-2014 & 2020-2022). (16) Dr. P. M. Patil, M.Sc., Ph.D. (2018-2020). (17) Dr. P. G. Patil, M.Sc., Ph.D. (2022-2024). (18) Dr. S. C. Shiralashetti, M.Sc., PGDCA, M.Phil., Ph.D. (2024-2026).

However, (1) Prof. P. N. Shivakumar (1958-1966) (2) Prof. K. Sundareshan (1961-1962) (3) Prof. H.S. Gopalakrishna (1961-1982) (4) Prof. Sanatani (1966-1967) (5) Dr. S. B. Gokhale (1968-1972) (6) Dr. V. N. Kulkarni (1968-1983) (7) Dr. G. R. Hiremath (1968-1981) (8) Prof. Smt. Nirmala Agashe (1972-1974) (9) Dr. D. J. Shetty (1976-1983) (10) Dr. P. S. Hiremath (1986-1992) (11) Dr. H. B. Walikar (1989-2007) (12) Dr. S. N. Gaikwad (2012-2012) (13) Dr. D. G. Prakasha (2009-2019) (14) Sri. Kumbinarasaiah. S. (2014-2020), were the faculty members served in the Department without heading as Chairman of the Department of Mathematics, Karnatak University, Dharwad.

Presently, Prof. S. C. Shiralashetti, Professor of Mathematics heading the Department as Chairman. Sr. Prof. H. S. Ramane, Prof. P. G. Patil and Prof. S. C. Shiralashetti, Faculty members working in the Department since, 2013. Prof. Smt. R. S. Dyavanal, Faculty member working in the Department since, 2009. Dr. Asha. S. K., Faculty member working in the Department since, 2012.

Vision of the Mathematics Department: To strengthen multi-disciplinary, technology-enabled education, Promote research for innovation and innovative courses in Mathematics, Train students as responsible future citizens who will strive towards creating a sustainable society.

Mission of the Mathematics Department: 1. To deliver quality education, emphasizing experiential learning with state of-the-art infrastructure. 2. To create a conducive environment for multi-disciplinary research and innovation. 3. To develop professionals through holistic education focusing on all round growth, discipline, ethics, and social sensitivity. 4. To nurture industry-institution collaboration leading to competency enhancement and Entrepreneurship. 5. To strengthen the adoption of technology ensuring a sustainable and inclusive society. 6. To adopt and strengthen e-governance for time-bound delivery of educational services to mould and prepare young Mathematicians equipped with very strong and sound fundamental principles and logical tools of Mathematics to face the challenges of the next generation multidisciplinary environment and to train to play the role of fulfilling the needs of science and technology, industry, institutions, research and academics.

In the process of introducing CBCS in the Karnatak University Dharwad only M.Sc Degree in Mathematics has been offered and continued under NEP.

GENERAL INSTRUCTIONS

I. CREDIT, WORKLOAD AND SYLLABUS EQUIVALENCE:

1. One credit is equal to 1 hour theory teaching per week.
2. One credit is equal to 2 hour practical teaching per week.
3. One credit is equal to 15 hours theory syllabus per semester (1 Unit is equal to 15 Hours).
4. One credit is equal to 30 hours practical syllabus per semester (1 credit practical is equal to 2 hours per week).

A. Workload for Theory Subjects:

1. There shall be 16 hrs/week workload for Assistant Professor.
2. There shall be 14 hrs/week workload for Associate Professor/Professor/Senior Professor.
3. There shall be 2hrs/week workload relaxation for Guiding Ph.D. students.

B. Workload for Practical Subjects:

1. There shall be 20 hrs/week workload for Assistant Professor.
2. There shall be 18 hrs/week workload for Associate Professor/Professor/Senior Professor.
3. There shall be 2hrs/week workload relaxation for guiding Ph.D. students.

C. Workload for Practical Batches:

1. A batch of 10-12 students shall have 1 teacher.

D. Workload for Project:

1. Students for projects / internship shall be preferably guided by permanent faculty for atleast10 students by sharing equally among the permanent faculty. If remained excess shall be allotted to other teacher's onroll on temporary basis.
2. If there are no permanent faculty, the students shall be distributed among the temporary teachers onroll.
3. There shall be maximum of 4 hrs/week workload for guiding the students for project work irrespective of number of students.

II.ALLOTMENT OF SPECIALIZATION:

While allotting specialization in 3rd and 4th semester, minimum of 10 students shall have to select the specialization.

III. ATTENDANCE:

75% attendance is mandatory for every course (paper). No marks are reserved for attendance. If the candidates fail to fulfill 75% attendance in any one of the course (paper) in the given semester, such candidate is not eligible to appear for examination in all the papers and candidate has to get the readmission for such semester. However, up to 20% attendance may be condoned with the supportive documents for a student who represents University /State / National level sports, cultural and other events. Monthly attendance shall be displayed on notice board.

IV. CREDIT AND MARKS EQUIVALENCE:

1. Generally, 20% weightage for Formative assessment and 80% weightage forSummative assessment.
2. Upto 2 credits equal to 50 marks (10 marks Formative assessment and 40 marks summative assessment).
3. 3-4 credits equal to 100 marks(20 marks Formative assessment and 80 marks summative assessment).
4. 5-6 credits equal to 150 marks(30 marks Formative assessment and 120 marks summative assessment).
5. Example for 100 marks out of which 20 marks for Formative assessment i.e., Formative Assessment shall be in two internal assessments i.e.: 10 marks I.A. for 8th week and 10 marks for 14thweek of every semester.

V. CONDUCT OF EXAMINATION:

1. Formative assessment examination shall be conducted for 1hr. There shall not be any provision for improvement. A special Formative assessment examination shall be conducted for a student who represents University /State / National level sports, cultural and other events if a schedule is overlapping.
2. 80 marks summative theory examination shall be conducted for 3 hrs and 40 marks for 1.5 hrs.
3. 80/ 40 marks Formative / Summative Practical examination shall be conducted for 4 hrs.
4. There shall be a single examiner for both even and odd semesters’ Formative Practical examination.

5. There shall be a single examiner for odd semester Summative Practical examination and two examiners for even semester Summative Practical examination; one from internal and other shall be external examiner.

VI. ASSESSMENT:

1. **Theory Papers:** There shall be a single valuation for odd semester theory papers preferably internal examiner and double valuation for even semesters; one from internal and other shall be external examiner.
2. **Project/Internship Assessment:**

   A) **For100 Marks Project/Internship Assessment (Wherever Applicable):**

   i. **Formative Assessment**: Project/Internship assessment carrying 20 marks out of 100 marks, Candidate has to submit two Progress Reports; each carries 10 Marks. i.e., 10 x 2= 20 marks.

   ii. **Summative Assessment**: Project/Internship assessment carrying 80 marks out of 100 marks

   a. Project Report : 35

   b. Presentation : 25

   c. Viva-voce : 20

   B) **For150 Marks Project/Internship Assessment (Wherever Applicable):**

   i. **Formative Assessment**: Project/Internship assessment carrying 30 marks out of 150 marks, Candidate has to submit two Progress Reports; each carries 15 Marks. i.e., 15 x 2= 30 marks.

   ii. **Summative Assessment:** Project/Internship assessment carrying 120 marks out of 150 marks

   a. Project Report : 60

   b. Presentation : 35

   c. Viva-voce : 25

VII. PASSING CRITERIA:

1. There shall be no minimum passing marks for Formative assessment.
2. Candidate has to score minimum 40% in summative examination and fulfill 40% of the maximum marks including Formative assessment marks. For example: for 80 marks summative examination, candidate has to score minimum of 32 marks (40%) and should score cumulatively 40 marks including formative assessment in every

course.

VIII. DECLARATION OF RESULT:

1. Candidate has to score 40% as above in all the courses to pass the semester end examination to declare pass.
2. **Percentage and Grading:** Result shall be declared in terms of SGPA and at the end of four semesters as CGPA. The calculation of CGPA is as under.
3. If P is the percentage of marks secured (IA + semester end score) by the candidate in a course which is rounded off to the nearest integer, the grade point (GP) earned by the candidate in that course will be given as below.

Percentage (%)	Grade(GP)	Percentage (%)	Grade(GP)
40	4.0	71-75	7.5
41-45	4.5	76-80	8.0
46-50	5.0	81-85	8.5
51-55	5.5	86-90	9.0
56-60	6.0	91-95	9.5
61-65	6.5	96-100	10.0
66-70	7.0		

   Grade point of less than 4 shall be considered as fail in the course, hence, GP=0 and for the absent candidate also GP=0.

4. A student’s level of competence shall be categorized by grade point (GP), Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) of the programme.
5. **Semester Grade Point Average (SGPA):** The SGPA is a ratio of sum of the number of Credit Grade Points scored from all the courses (subject) of given semester to the total credits of such semester in which the candidate studied. (Credit Grade Points of each course = Credits x GP).
6. **Cumulative Grade Point Average (CGPA):** It is calculated as below for 4 semester programme.

   CGPA=(Credit$_1$ x SGPA$_1$) + (Credit$_2$ x SGPA$_2$) +(Credit$_3$ x SGPA$_3$) + (Credit$_4$ x SGPA$_4$) / Total credits of programme (sum of credits of 4 semesters).

7. After studying and passing, all the credits prescribed for the programme the degree shall be awarded with CGPA score after rounding off to second decimal and class

distinguishing as second class, first class, and distinction along with grade letter as under:

CGPA of the Programme(Degree)	Class Obtained	Grade Letter
9.5 to 10.00	Outstanding	A^{++}
7.00 to 9.49	Distinction	A^{+}
6.00 to 6.99	First Class	A
5.50 to 5.99	Second class	B^{+}
5.00 to 5.49		B
4.00 to 4.99	Pass	C
Less than 4.0	Fail/ Reappear	D

8. Each semester Grade Card shall have marks and SGPA and final Grade Card shall have semester wise marks obtained in all semesters, CGPA and % of cumulative marks obtained from all semesters.
9. There shall be Revaluation / Challenge valuations provisions as per the prevailing rules and regulations.
10. Marks obtained from the OEC shall not be considered for award of CASH PRIZE / RANK / GOLD MEDAL.

IX. MAXIMUM DURATION FOR COMPLETION OF THE PROGRAMME:

A candidate admitted to any P.G. Programme shall complete it within a period, which is double the duration of the programme from the date of admission.

X.ANY OTHER TERMS AND CONDITIONS:

Apart from the above, the prevailing rules and regulation are valid for any other matters which are not addressed in this regard.

KARNATAK UNIVERSITY DHARWAD

M.Sc. in MATHEMATICS

Effective from 2024-25

Semester	Type of Course	Theory /Practical	Course Code	Course Title	Instruction hours / week	Total hours of syllabus / Sem	Duration of Sem End Exam	Marks			Credits
								Formative Assessment	Summative Assessment	Total	
I	DSC – 1	Theory	A1MAT001T	Algebra	04	60	03	20	80	100	04
	DSC – 2	Theory	A1MAT002T	Real Analysis	04	60	03	20	80	100	04
	DSC – 3	Theory	A1MAT003T	Complex Analysis – I	04	60	03	20	80	100	04
	DSC – 4	Theory	A1MAT004T	Topology - I	04	60	03	20	80	100	04
	DSC – 5	Theory	A1MAT005T	Operations Research	04	60	03	20	80	100	04
	DSC – 6	Practical	A1MAT006P	C-Programming Lab	08	120	04	20	80	100	04
								120	**480**	**600**	**24**
II	DSC – 7	Theory	A2MAT001T	Linear Algebra	04	60	03	20	80	100	04
	DSC – 8	Theory	A2MAT002T	Complex Analysis – II	04	60	03	20	80	100	04
	DSC – 9	Theory	A2MAT003T	Topology – II	04	60	03	20	80	100	04
	DSC – 10	Theory	A2MAT004T	Ordinary Differential Equations	04	60	03	20	80	100	04
	OEC – 1	Theory	A2MAT205T	Discrete Mathematical Structures and Differential Calculus	04	60	03	20	80	100	04
	DSC – 11	Practical	A2MAT006P	MATLAB-Programming Lab	08	120	04	20	80	100	04
								120	**480**	**600**	**24**

III	DSC – 12		Theory	A3MAT001T	Partial Differential Equations and Numerical Methods	04	60	03	20	80	100	04
	DSC – 13		Theory	A3MAT002T	Measure Theory and Integration	04	60	03	20	80	100	04
	DSC – 14		Theory	A3MAT003T	Fluid Mechanics	04	60	03	20	80	100	04
	DSE – 1	(A)	Theory	A3MAT104AT	Nevanlinna Theory	04	60	03	20	80	100	04
		(B)		A3MAT104BT	Discrete Mathematical Structures							
		(C)		A3MAT104CT	Number Theory							
	OEC – 2		Theory	A3MAT205T	Fuzzy Sets and Numerical Methods	04	60	03	20	80	100	04
	DSC – 15		Practical	A3MAT006P	MAPLE-Programming Lab	08	120	04	20	80	100	04
									120	**480**	**600**	**24**
IV	DSC – 16		Theory	A4MAT001T	Functional Analysis	04	60	03	20	80	100	04
	DSC – 17		Theory	A4MAT002T	Fuzzy Topology	04	60	03	20	80	100	04
	DSC – 18		Theory	A4MAT003T	Wavelet Theory	04	60	03	20	80	100	04
	DSE – 2	(A)	Theory	A4MAT104AT	Graph Theory	04	60	03	20	80	100	04
		(B)		A4MAT104BT	Differential Geometry							
		(C)		A4MAT104CT	Classical Mechanics							
	DSC – 19		Practical	A4MAT005P	MATHEMATICA-Programming Lab	08	120	04	20	80	100	04
	DSC – 20		Practical	A4MAT006P	Project Work	08	120	04	20	80	100	04
									120	**480**	**600**	**24**

* Each DSE theory shall have minimum two and maximum 3 papers and student shall select any one DSE each in 3rd and 4th semester.

KARNATAK UNIVERSITY DHARWAD

M.Sc. in MATHEMATICS

Programme Specific Outcomes (PSOs):

On completion of the 02 years Master's Degree in Mathematics, students will be able to:

PSO 1	**Advanced Mathematical Knowledge:** Acquire a comprehensive understanding of foundational mathematical concepts including algebra, real analysis, differential equations, etc.
PSO 2	**Problem-solving Skills**: Develop strong analytical and problem-solving skills through the application of mathematical principles to real-world problems.
PSO 3	**Mathematical Modelling**: Gain proficiency in mathematical modelling techniques to analyse and solve complex problems across various disciplines such as physics, economics, engineering, and computer science.
PSO 4	**Abstract Reasoning**: Develop the ability to think abstractly and logically, and to construct rigorous mathematical proofs to support assertions and theorems.
PSO 5	**Computational Mathematics**: Acquire computational skills necessary for mathematical analysis and exploration using software tools such as C-Programming, MATLAB, MATHEMATICA and MAPLE.
PSO 6	**Differential Equations Proficiency**: Attain proficiency in solving ordinary and partial differential equations, and understand their applications in various scientific and engineering disciplines.
PSO 7	**Numerical Methods**: Learn numerical methods for approximating solutions to mathematical problems, including numerical integration, differentiation, and solving differential equations.
PSO 8	**Mathematical Software Applications**: Utilize mathematical software effectively for visualization, simulation, and analysis of mathematical concepts and data.
PSO 9	**Mathematical Communication**: Develop clear and concise mathematical communication skills, both written and oral, to effectively convey mathematical ideas and results to diverse audiences.
PSO 10	**Interdisciplinary Applications**: Recognize and apply mathematical concepts to interdisciplinary areas, fostering the ability to adapt mathematical knowledge to various domains.

M.Sc. Semester – I

Subject: MATHEMATICS

Discipline Specific CoreCourse (DSC)

Course Title: Algebra

Course Code: A1MAT001T (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 1	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:

CO 1: Understand the concepts of Sylow's theorem.
CO 2: Explain and demonstrate accurate and efficient use of advanced techniques.
CO 3: Prove and explain the concepts from advance algebra.
CO 4: Understand rings, ideals, field and Euclidean domain.
CO 5: Find the roots of polynomials.
CO 6: Understand the characteristic of rings and fields.
CO 7: Understand the fundamental concepts of homomorphism and their role in mathematics.

Unit	**Title:** Algebra	60 Hours / Sem
Unit – I	**Groups:**	15 Hrs.
	Groups, Normal subgroups, Quotient groups, Group homomorphism, Kernel of homomorphism, isomorphism, Permutation group, Symmetric group S_n, Automorphism, Inner automorphism, Structure of cyclic groups, Conjugate elements, centralizer (normalizer) of an element.	
Unit –II	**Structure of Groups:**	15 Hrs.
	Structure theory of groups, Direct products, Finite Abelian group, Cauchy theorem for abelian group, Cauchy theorem for finite group, Syllow's theorems, Subnormal series, Solvable groups, Solvability of S_n, Composition series of a group, Jordan-Holder theorem.	
Unit –III	**Rings:**	15 Hrs.
	Rings, subrings, ideals, Integral domain, Quotient rings, homomorphism of rings, Polynomial rings, Factorixzation in R[X], Prinicpal ideal domain, Euclidean domain, Unique Factorization domain.	
Unit – IV	**Fields:**	15 Hrs.
	Fields, subfields, prime fields, characteristic of fields, Field extension, finite extension, algebraic extension, simple extension, Roots of polynomials, Splitting field of a polynomial.	

References:

1.I. N. Herstein:Topics in Algebra, John-Wiley & Sons, New York (2022).

2.Surjeet Singh and QaziZameeruddin: Modern Algebra, Vikas Publishing House (2006).

3. M. Artin: Algebra, Pearson Education (2024).

4. S. K. Jain, P. B. Bhattacharya and S. R. Nagpaul: Basic Abstract Algebra, Cambridge University Press (2001).

5. S. Maclane and G. Birkhoff: Algebra, The Orient Blackswan (2013).

6. Hunger Ford: Abstract Algebra, Cengage Publication (2015).

7. Joseph A. Gallian: Contemporary Abstract Algebra, Cengage India Pvt. Ltd. (2019).

8. J. J. Rotman, The Theory of Groups-An Introduction, Allya & Bacon, 1965.

FormativeAssessmentforTheory	
AssessmentOccasion/ Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – I

Subject: MATHEMATICS

Discipline Specific Core Course (DSC)

Course Title: Real Analysis

Course Code: A1MAT002T (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 2	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:

CO 1: Recognize open, closed, connected and compact subsets of *R*.

CO 2: Explain the basic theory of metric space and its related concepts.

CO 3: Understand order completeness of *R*.

CO 4: Determine the Riemann integrability of a bounded function.

CO 5: Apply the Mean Value Theorem and the Fundamental Theorem of Calculus to problems in the context of real analysis.

CO 6: Analyse uniform continuity and convergence.

CO 7: Apply Inverse and Implicit Function Theorems in R^n.

Unit	**Title:** Real Analysis	60 Hours / Sem
Unit – I	**Topology of *R* and Metric Spaces:**	**15 Hrs.**
	Euclidean Topology on R: Open, Closed subsets of R, Computation of interior, exterior, boundary and closure for some subsets of R, Dense subsets of R, Bolzano-Weierstrass theorem, Heine-Borel theorem, Metric spaces, Compactness, Connectedness, Sequences, Subsequences and Cauchy sequences in a metric space. R as a complete metric space, Limit,Continuity and Connectedness, Kinds of discontinuities.	
Unit – II	**Differentiation and Riemann-Stieltjes Integral:**	**15 Hrs.**
	Differentiation, Mean value theorems, The continuity of derivatives, Derivativesof higher orders, Taylor's theorem, Analytic functions, Functions of class C^∞(which arenot analytic), Riemann-Stieltjes integral, its existence and linearity, The integral as a limit of sum,Change of variables, Functions of bounded variation, Thefundamental theorem of calculus.	

Unit – III	**Sequences and Series of Functions:**	**15 Hrs.**
	Absolute and conditional convergence of series, Riemann's derangement theorem,Sequences and series of functions, Uniform convergence, Uniform convergence andcontinuity, Uniform convergence and integration, Uniform convergence and differentiation,The Stone-Weierstrass theorem.	
Unit – IV	**Functions of Several Variables:**	**15 Hrs.**
	Euclidean space R^n as a real vector space and a real inner product space, Topology of R^n, Component functions of *f*, Limits, Continuity, Differentiation and their partial derivatives, Contraction principle, Inverse function theorem, Implicit function theorem, Rank theorem, Determinants, Jacobian.	

References:

1. W. Rudin: Principles of Mathematical Analysis, McGraw Hill BookCo. (2023).
2. W.R. Wade: An Introduction to Analysis, Pearson Education (2019).
3. R. G. Bartle and D. R. Sherbert: Introduction to Real Analysis, Wiley (2021).
4. L. W. Cohen and G. Ehrlich: The Structure of the Real Number System, Literary Licensing (2012)
5. W. H. Fleming: Functions of Several Variables, Addison Wesley (1968)
6. M. Moskowitz and F. C. Paliogiannis: Functions of Several Real Variables, World Scientific (2011).
7. C. Goffman: Calculus of Several Variables, Harper series (1965).

FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – I

Subject: MATHEMATICS

Discipline Specific Core Course (DSC)

Course Title: Complex Analysis-I

Course Code: A1MAT003T (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 3	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:

CO 1: Understand Cauchy-Riemann equations.

CO 2: Discuss the convergence of power series expansions.

CO 3: Use Cauchy's Theorem, and Cauchy's Integral Formulae to solve contour integration.

CO 4: Express an analytic function in terms of power series in the domain of analyticity.

CO 5: Understand the characteristic of a complex function in the neighbourhood.

CO 6: Acquire the skill of contour integration to evaluate complicated real integrals via residue calculus.

CO 7: Understand classification of singularities.

Unit	**Title:** Complex Analysis–I	60 Hours / Sem
Unit – I	**Functions of Complex Variable:**	15 Hrs.
	Limit, continuity and derivative of functions of complex variable, Analytic functions and their properties, related problems.	
Unit – II	**Power Series and Elementary Functions:**	15 Hrs.
	Radius of convergence, Cauchy-Hadamard theorem, Power series as an analytic function, exponential, trigonometric, hyperbolic, inverse trigonometric, inverse hyperbolic, logarithmic functions, related problems.	
Unit – III	**Complex Integration:**	15 Hrs.
	Path in a region, Contour, Complex integration, Cauchy-Goursat theorem, Cauchy integral formula, Extension of Cauchy integral formula for multiple connected domain, Cauchy's inequality, Liouville's Theorem, Fundamental theorem of Algebra, Morera's theorem, Taylor's theorem and related problems.	

Unit – IV	**Singularities and Residues:**	**15 Hrs.**
	Laurent series, Classification of singularities, Behaviour of an analytic function in the neighbourhood of a singularity, Isolated singularity at infinity, Residue at a finite point and at the point at infinity, Cauchy's residue theorem, Evaluation of improper integrals, Jordan's lemma, Definite integrals involving sines and cosines, related problems.	

References:

1. L. V. Ahlfors: Complex Analysis, Second Edition, McGraw Hill Book Co. (1966).
2. John B. Conway: Functions of one Complex variable,Springer Verlag (1973).
3. J. W. Brown and R. V. Churchill: Complex Variables and Applications,McGraw Hill (2021)
4. T. O. Moore and E. H. Hadlock: Complex Analysis, Allied Publishers Ltd. (1993).
5. Serge Lang: Complex Analysis, Addison – Wesley, Publishing Company (1997).
6. H. S. Kasana:Complex Variables, Prentice Hall India Learning Pvt. Ltd. (2005).
7. A. Bourchtein and L. Bourchtein: Complex Analysis, Springer Verlag (2022).
8. S. Kumaresan: A Pathway to Complex Analysis, Techno World (2021).
9. I. Stewart: Complex Analysis, Cambridge University Press (2018).
10. S. Ponnusamy: Foundations of Complex Analysis, Narosa (2011).

FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – I

Subject: MATHEMATICS

Discipline Specific Core Course (DSC)

Course Title: Topology - I

Course Code: A1MAT004T (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 4	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:

CO 1: Define open sets, closure of a set and interior of a set.

CO 2: Analyse bases and subbasis.

CO 3: Use continuous functions and homeomorphisms to understand structure of topological spaces.

CO 4: Understand the concepts and properties of the compact, locally compact and connected topological spaces.

CO 5: Define the separation axioms in the topological spaces and study its characteristics.

CO 6: Explain the compactness and connectedness properties in the topological space.

CO 7: Exhibit the importance of nets and filters.

Unit	**Title:** Topology – I	60 Hours / Sem
Unit – I	**Introduction to Topology:**	15 Hrs.
	Topological Space, Types of topological spaces, Open sets, Closed sets, Closure, Accumulation points, Derived sets, Interior, Boundary,Bases and subbasis, Dense sets, Neighbourhood system, Subspaces.	
Unit – II	**Continuity:**	15 Hrs.
	Topological Mappings: Continuous maps, Continuity at a point, Continuous maps into R, Open and closed maps, Homeomorphisms, Pasting Lemma, Finite product spaces, Quotient spaces, Projection maps.	
Unit – III	**Separation Axioms and Connectedness:**	15 Hrs.
	Separation Axioms: T_0, T_1 and T_2 spaces. **Connectedness:**Connected and disconnected spaces, Intermediate value theorem, Components, Local connectedness, Path connectedness.	

Unit – IV	**Compact and Metric Spaces :**	**15 Hrs.**
	Compactness: Compactness, Characterizations, Invariance of compactness under maps, Properties. **Metric Spaces:**Metrics on sets, Open sphere, Topology induced by a metric, Equivalent metrics.Nets and Filters, Topology and convergence of nets, Hansdorffness and nets, Compactness and nets, Filters, Convergence of filters, Ultrafilters, Cauchy filters.	

References:

1. J. R. Munkers: Topology, Pearson Education (2021).
2. J.L.Kelley: General Topology, Harpe Collins (2017).
3. K. D. Joshi: Introduction to General Topology, New Age International Publishers (2017).
4. G. F. Simmons: Introduction to Topology and Modern Analysis, Medtec (2024).
5. N. Bourbaki: General Topology, Part I, Springer (1998).
6. S. Kumaresan: Topology of Metric Spaces, Narosa Publishing House (2014).
7. S. Lipschutz: General Topology, Schaum's series, McGraw Hill Int. (1981).
8. C. W. Baker: Introduction to topology, W. C. Brown Publisher (1991).
9. S. Nanda and S. Nanda: General Topology, Oxibh (2013).
10. S. Willard: General Topology, Dover Publications (2004).
11. S. R. Malghan: General Topology, Serials Publications (2012).
12. James Dugundji: Topology, Allyn and Bacon (Reprinted by PHI & UBS).

FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – I

Subject: MATHEMATICS

Discipline Specific Core Course (DSC)

Course Title: Operations Research

Course Code: A1MAT005T (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 5	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:

CO 1: Formulate Linear Programming problem (LPP).
CO 2: Apply methods to solve LPP.
CO 3: Figure out the advantages of duality.
CO 4: Understand Transportation Problems.
CO 5: Discuss Assignment Problems.
CO 6: Compute Game Theory Problems.
CO 7: Analyse stochastic process.

Unit	**Title:** Operations Research	60 Hours / Sem
Unit – I	**Linear Programming Problems:**	**15 Hrs.**
	Introduction,MathematicalFormulation of a Linear Programming Problems (LPP), Graphical method of solving an LPP, Fundamental Theorem of LPP,Preamble for the simplex method, Introduction to Simplex method, Slack and Surplus variables, Canonical and Standardforms of a LP problem, Simplex method algorithm, Big M Method, Degeneracy in LPP.	
Unit – II	**Concept of duality:**	**15 Hrs.**
	Introduction, Advantages of duality, Definition of the dual problem, Formulation of dual from primal and problems,Duality theorem, Examples applying the principle of duality, Dual Simplex Method and problems.	
Unit – III	**Transportation and Assignment Problems:**	**15 Hrs.**
	Transportation Problem: Introduction, Applications of Transportation Model, Formulation of Transportation Model, Basic Feasible Solution using different methods, North-West Corner Rule, Least Cost or Matrix Minima Method, Vogel's Approximation Method, Optimality Methods, Modified Distribution (MODI) Method, Degeneracy in Transportation Problems. **Assignment Problems:** Introduction, Differences between Transportation and Assignment problems, Hungarian Algorithm to solve Assignment problems, Unbalanced Assignment problems, Maximization in Assignment, Prohibited or Restricted Assignments, Travelling Salesman Problem.	

Unit – IV	**Game and Queuing Theories:**	**15 Hrs.**
	Game Theory: Introduction, Characteristics or Features of a Game,Game Theory Terminology, Classification of Game theoryProblems, The Maximin-Minimax principle for pure strategies, problems, Mixed Strategy- Games without saddle point: Analytical method of solving (2×2) Matrix. **Queueing Theory:**Introduction, Characteristics of Queueing System, Pure-birth and Pure-death models, Kendall's Notation for representing Queueing Models, Classification of Queueing Models, (M/m/1): (∞/FCFS) Model and Problems. **Markov Chains:**Introduction, Probability vectors, Stochastic matrices, Fixed points and Regular stochastic matrices, Markov chains, higher transition probabilities, stationary distribution of regular Markov chains and absorbing states, problems. **PERT - CPM Techniques:**Introduction, Phases or Basic steps involved in PERT/CPM techniques, Advantages of PERT/CPM and other Network techniques, Applications of PERT/CPM, Differences between PERT and CPM, PERT and CPM terminology, Common errors committed in Network construction, AON and AOA diagrams, Fulkerson's Rule for numbering the events of a network, Examples in construction of Network.	

References:

1. H. Taha: Operations Research, Global EduTech (2019).
2. B.E. Gillett: Introduction to Operations Research, a Computer Oriented Algorithmic Approach, McGraw Hill Education (2008).
3. F.S. Hiller, G.J. Liebermann, B. Nag and P. Basu: Introduction to Operations Research, McGraw Hill Education (2021).
4. C. K. Mustafi: Operations Research, New Age International Pvt. Ltd. (1998).
5. J. K. Sharma: Operations Research: Theory and Applications, Laxmi Publications Pvt. Ltd. (2023).
6. S. D. Sharma: Operations Research, Kedar Nath Ram and Company, Meerut (2014).
7. R. K. Hegde: Operations Research, Sapna Book House (P) Ltd. (2013).
8. K. R. Phaneesh:Operations Research, Sudha Publications (2013).

FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – I

Subject: MATHEMATICS

Discipline Specific Core Course (DSC)

Course Title:C-Programming Lab

Course Code: A1MAT006P (Practical)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 6	Practical	04	08	120 Hrs.	04 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Practical), students will be able to:

CO 1: Learn C-programming software, which is a basic programming language.

CO 2: Calculate area and perimeter of circle and triangle.

CO 3: To find sum, difference and product of a matrix using C-Programming software.

CO 4: Solve numerical problemsusing C-Programming software.

CO 5: Solve equations using Newton Raphson method.

CO 6: Acquire knowledge to solve system of linear equations.

CO 7: Find the polynomial using Lagrange's interpolation formula.

List of Experiments

1. Program to find area and perimeter of a circle and triangle.
2. Program to check whether the given year is leap or not.
3. Program to find largest of three numbers.
4. Program to check whether the given number is even or odd.
5. Program to find factorial of a number.
6. Program to find the roots of a quadratic equation.
7. Program to accept a number to display its corresponding month using switch statement.
8. Program to find sum, difference and product of two matrices.
9. Program to find root of a given equation using Bisection method.
10. Program to find root of a given equation using Newton-Raphson method.
11. Program to solve the system of linear equations by Gauss-elimination method.
12. Program to solve the system of linear equations by Gauss-Jordan method.

13. Program to solve the system of linear equations by using LU decomposition method.
14. Program to solve the system of linear equations by Gauss-Seidel method.
15. Program to find the value of $y = f(x)$ using Newton's forward interpolation formula.
16. Program to find the value of $y = f(x)$ using Newton's backward interpolation formula.
17. Program to find the value of $y = f(x)$ using Lagrange's interpolation formula.
18. Program to find integral of a function using Trapezoidal rule.
19. Program to find integral of a function using Simpson's $(1/3)^{rd}$ rule.
20. Program to find integral of a function using Simpson's $(3/8)^{th}$ rule.

Instructions

1. Software to be used: C-Programming.

2. During the semester, student should cover up the below mentioned C-Programming syllabus in the form of assignments and seminars.

Title: C-Programming Lab
Basics of C-Programming Language:
Basic structure of a C – program, Character set, Constants and variables, Data types, Declaration of variables, Assignment statement, Symbolic constants, Arithmetic operators, Relational operators, Logical operators, Assignment operators, Increment and decrement operators, Conditional operator, Aithmetic expressions – evaluation, Input / output operations: reading / writing a character, Formatted input / output.
Decision making and branching:
IF statement, If-else statement, Nested if ….. else statements, else if ladder, switch statement, the ? : operator, GO TO statement. Decision making and Looping: The while loops, do statement, for statement, jumps in loops. Arrays: One and two dimensional arrays and initialization, Multidimensional arrays, Structures, Pointers and file handling.

References:

1. V. Rajaraman and N. Adabala: Fundamentals of Computers, PHI (2014).
2. E. Balagurusamy: Programming in ANSI – C, McGraw Hill Pub. Co. (2024)
3. B. S. Gottfried: Programming with C, Tata McGraw Hill (Schaum's Outlines) (2018)
4. B. W. Kernighan and D. M. Ritchie: The C programming Language, Pearson Education India (2015)
5. V. K. Gupta: A Text Book of C Programming, Khanna Publishers (2020)
6. M. Cooper: The Spirit of 'C' – An introduction to modern programming, Jaico Pub. House (1998)
7. S. K. Srivastava and Deepali Srivastava: C in Depth, BPB Publications (2009).

Scheme of Practical Examination (Distribution of Marks)

FormativeAssessmentforPractical	
AssessmentOccasion /Type	**Marks**
Program writing and problem solving (2 Programs)	(3+3)*2 = 12
Program Execution (2 Programs)	04
Viva	02
Journal	02
Total	**20Marks**
FormativeAssessmentasperguidelines.	

SummativeAssessmentforPractical	
AssessmentOccasion /Type	**Marks**
Program writing and problem solving (2 Programs)	(10+10)*2 = 40
Program Execution (2 Programs)	20
Viva	10
Journal	10
Total	**80Marks**
SummativeAssessmentasperguidelines.	

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M.Sc. Semester – II

Subject: MATHEMATICS

Discipline Specific Core Course (DSC)

Course Title: Linear Algebra

Course Code: A2MAT001T (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 7	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:
CO 1: Understand Vector spaces.
CO 2: Verify linear independence and dependence characteristics of a given vector.
CO 3: Apply Linear Transformations.
CO 4: Compute eigenvalues and eigenvectors.
CO 5: Formulate the diagonalization of matrices.
CO 6: Understand canonical forms.
CO 7: Analyse Jordan blocks and Jordan forms.

Unit	Title: Linear Algebra	60 Hours / Sem
Unit – I	**Vector Spaces:**	**15 Hrs.**
	Definition and examples of vector spaces, Subspaces, Sum and direct sum of subspaces,Linear span, Linear dependence, independence and their basic properties, Basis, Finite dimensional vector spaces, Existence theorem for bases, Invariance of number of elements of a basis set,Dimension, Existence of complementary subspace of a subspace of a finite dimensional vector space,Dimension of sums of subspaces, Quotient space and its dimension.	
Unit – II	**Linear Transformations:**	**15 Hrs.**
	Linear transformations and their representation as matrices, The algebra of linear transformations, The rank nullity theorem, Change of basis, Dual space, Bidual space and natural isomorphism, Adjoint of a linear transformation.	
Unit – III	**Eigenvalues and Eigenvectors:**	**15 Hrs.**
	Eigenvalues and eigenvectors of a linear transformation, Algebraic and geometric multiplicity of eigenvalues, Diagonalization, Annihilator of a subspace,Quadratic forms, Classification of real quadratic forms, Bilinear forms, symmetric and skew-symmetric bilinear forms, Hermitian forms, Solutions of homogeneous systems of linear equations.	
Unit – IV	**Canonical Forms:**	**15 Hrs.**
	Orthogonal and orthonormal vectors, Gram-Schmidt orthogonalization process,Canonical forms, Similarity of linear transformations, Invariant subspaces, Reduction to triangular forms, Nilpotent transformations, Index of nilpotency, Invariants of a linear transformation, Primary decomposition theorem,Minimal polynomial, Jordan blocks and Jordan canonical forms.	

References:

1. I. N. Herstein: Topics in Algebra, Wiley Eastern Ltd., New York (1975).
2. S. Lang: Introduction to Linear Algebra, 2nd Edition, Springer – Verlag (1986).
3. K. Hoffman and R. Kunze: Linear Algebra, Prentice Hall India Learning Pvt. Ltd. (2015).
4. Surjit Singh: Liner Algebra, Vikas Publishing House Pvt. Ltd. (1997).
5. L. Smith: Linear Algebra, Springer – Verlag, New York (1984).
6. A. R. Rao and P. Bhimashankaram: Linear Algebra, Hindustan Book Agency (2000).
7. David C. Lay: Linear Algebra and its Applications, Pearson Education (2023).
8. Gilbert Strang: Linear Algebra, Cengage India Pvt. Ltd. (2005).
9. S. Kumareson: Linear Algebra: A Geometric Approach, Prentice Hall India Learning Pvt. Ltd. (2000).
10. S. H. Friedberg, A. J. Insel and L. E. Spence: Linear Algebra, Pearson Education (2022).

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FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – II

Subject: MATHEMATICS

Discipline Specific Core Course (DSC)

Course Title: Complex Analysis - II

Course Code: A2MAT002T (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 8	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:

CO 1: Understand the characteristic of analytic functions.

CO 2: Understand conformal mapping to compute geometric mappings.

CO 3: Discuss convergence of a sequence of complex functions.

CO 4: Understand the effect of uniform convergence.

CO 5: Extend analyticity continuation to analytic function and its natural boundary.

CO 6: Apply Riemann mapping theorem to real world problems.

CO 7: Understand Schwarz's Reflection Principle.

Unit	**Title:** Complex Analysis – II	60 Hours / Sem
Unit – I	**Maximum and Minimum Modulus Principles:**	15 Hrs.
	Winding number of a closed curve, Argument principle, Rouche`s theorem, Maximum modulus principle, Maximum and minimum modulus theorems, Hadamard`s three circles theorem and related problems.	
Unit – II	**Mapping and Inverse Function Theorems:**	15 Hrs.
	Schwarz`s lemma, Automorphism of unit disk, Some applications of Schwarz`s lemma, Basic properties of univalent functions, Open mapping theorem, Inverse function theorem, Local mapping theorem and related problems.	
Unit – III	**Conformal Mapping:**	15 Hrs.
	Conformal mapping, mapping of elementary transformations and the functions e^z, $sinz$, z^2, $z + \frac{k^2}{z}$, $\frac{1}{z}$, Bilinear transformation-basic properties, Cross ratio, Fixed points, Triples to triples, Symmetric points, The mapping from disc to disc, disc to half plane and half plane to half plane and related problems.	

Unit – IV	**Analytical Continuation:**	**15 Hrs.**
	Sequences and series of functions, Normal families, Weierstrass theorem, Hurwitz`s theorem, Montel`s theorem, Riemann mapping theorem, Analytic continuation of functions with natural boundaries, Schwarz`s reflection principle and related problems.	

References:

1. L. V. Ahlfors: Complex Analysis, Second Edition, McGraw Hill Book Co. (1966).

2. Shanti Narayan: Theory of Functions of a Complex Variable, S. Chand (2005).

3. John B. Conway: Functions of one Complex variable,Springer Verlag (1973).

4. J. W. Brown and R. V. Churchill: Complex Variables and Applications,McGraw Hill (2021)

5. T. O. Moore and E. H. Hadlock: Complex Analysis, Allied Publishers Ltd. (1993).

6. Serge Lang: Complex Analysis, Addison – Wesley, Publishing Company (1997).

7. H. S. Kasana: Complex Variables, Prentice Hall India Learning Pvt. Ltd. (2005).

8. S. Kumaresan: A Pathway to Complex Analysis, Techno World (2021).

9. I. Stewart: Complex Analysis, Cambridge University Press (2018).

10. S. Ponnusamy: Foundations of Complex Analysis, Narosa (2011).

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FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – II

Subject: MATHEMATICS

Discipline Specific Core Course (DSC)

Course Title: Topology - II

Course Code: A2MAT003T (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 9	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:

CO 1: Understand to construct the separation axioms using open and closed sets.

CO 2: Get the applications of Urysohn's lemma.

CO 3: Analyse countability axioms and separable spaces.

CO 4: Know the concepts of convergence and compactification.

CO 5: Demonstrate knowledge and understanding of metric spaces.

CO 6: Understand the convergence in metric spaces.

CO 7: Apply theoretical concepts in topology to understand the real world applications.

Unit	**Title:** Topology– II	60 Hours / Sem
Unit – I	**Separation Axioms:**	15 Hrs.
	Regular and T_3 spaces, Normal and T_4 spaces, Urysohn's lemma, Tietze's, extension theorem, Completely regular and Tychonoff spaces, Completely normal and T_5 spaces.	
Unit – II	**Countability Axioms:**	15 Hrs.
	First and second axioms of countability. Lindelof spaces, Separable spaces, Countably compact spaces, Limit point compact spaces, One point compactness, Separation and countability axioms in metric spaces, Convergence in metric spaces, Complete metric spaces.	
Unit – III	**Convergence in Topology:**	15 Hrs.
	Sequence and subsequences, Convergence in topology, Sequential compactness, Local compactness, Local finiteness, Refinements, Paracompactness and paracompact spaces. Arbitrary product spaces, Product invariance of separation and countability axioms, Tychonoff's theorem, Product invariance of connectedness.	

Unit – IV	**Algebraic Topology:**	**15 Hrs.**
	Homotopy of paths, Covering spaces, Fundamental group of circles, Retractions and fixed points, Fundamental theorem of algebra.	

References:

1. J. R. Munkers: Topology, Pearson Education (2021).
2. J. L. Kelley: General Topology, Harpe Collins (2017).
3. K. D. Joshi: Introduction to General Topology, New Age International Publishers (2017).
4. G. F. Simmons: Introduction to Topology and Modern Analysis, Medtec (2024).
5. N. Bourbaki: General Topology, Part I, Springer (1998).
6. S. Kumaresan: Topology of Metric Spaces, Narosa Publishing House (2014).
7. S. Lipschutz: General Topology, Schaum's series, McGraw Hill Int. (1981).
8. C. W. Baker: Introduction to topology, W. C. Brown Publisher (1991).
9. S. Willard: General Topology, Dover Publications (2004).
10. R. Engelking and K. Siekluchi: Topology: A Geometric Approach, Overseas Press (2005).
11. S. R. Malghan: General Topology, Serials Publications (2012).
12. James Dugundji: Topology, Allyn and Bacon (Reprinted by PHI & UBS).

FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – II

Subject: MATHEMATICS

Discipline Specific Core Course (DSC)

Course Title: Ordinary Differential Equations

Course Code: A2MAT004T (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 10	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:
CO 1: Solve linear differential equations of higher order.
CO 2: Solve differential equations by the method of undetermined coefficients.
CO 3: Understand Eigen value problems.
CO 4: Learn Laplace transforms and their applications.
CO 5: Analyse Bessel and Legendre Equations.
CO 6: Solve problems related toChebyshev polynomial.
CO 7: Understand Hermite and Laguerre Polynomials.

Unit	**Title:** Ordinary Differential Equations	60 Hours / Sem
	Higher Order Linear Differential Equations:	**15 Hrs.**
Unit – I	Second order ordinary differential equations with constant co-efficient, Non-homogeneous equations, Method of undetermined coefficients,Method of variation of parameters, Wronskian and linearly independent solutions. Equations reducible to linear equations with constant coefficients: Legendre's linear equation, Cauchy's linear equation. Qualitative properties of solutions. Sturm comparison theorem. Picard's method of solution of I.V.P., Strum-Liouville differential equation, Strum-Liouville problem, Eigen functions, and Eigen values, Orthogonality of Eigen functions, Reality of eigenvalues and Problems.	
	Laplace Transforms and Nonlinear ODE's:	**15 Hrs.**
Unit – II	Revision of Laplace Transforms and their Applications:Convolution,Convolution theorem, Laplace Transform of the convolution integral and solution of integral equations, Laplace transform of the derivatives, Solution of linear differential equations and simultaneous differential equations using Laplace transforms(Initial and Boundary value problems), Applications of Laplace transforms(Vibrations of string, Deflection of beams, L-R-C circuits and problems). Introduction to nonlinear order ordinary differential equations and their elementary properties, Homogeneous linear systems with constant co-efficient,Types of critical points and stability of linear systems,Simple critical points of nonlinear systems,Bendixson theorem and its applications.	

Unit – III	**Bessel and LegendreDifferential Equations:**	**15 Hrs.**
	Linear Second Order Ordinary Differential Equations with Variable Coefficients:Introduction, Series solution of an ordinary differential equation, Solution of Laplace equation in cylindrical system leading to Bessel differential equation, Series solution of the Bessel's differential equation and the associated Bessel function, Equations reducible to the form of Bessel's equation, Properties of Bessel function, Recurrence relations from the basic definition, Generating function for Bessel function, Recurrence relations from the generating function, Bessel Integral, Orthogonal property of Bessel functions. Solution of Laplace equation in spherical system leading to Legendre differential equation,Series solution of Legendre differential equation, Legendre polynomials, Generating function for Legendre polynomials, Rodrigue's formula, Recurence relations, Orthogonality of Legendre polynomials, Fourier-Legendre expansion.	
Unit – IV	**Chebyshev, Hermite and Laguerre Polynomials:**	**15 Hrs.**
	ChebyshevPolynomials: Definitions of Chebyshev Polynomials, Chebyshev Polynomials are independent solutions of Chebyshev differential equation, Orthogonal properties of Chebyshev polynomials, Recurrence relations, Theorems on Chebyshev polynomials, First few Chebyshev polynomials, Generating functions for Chebyshev polynomials, Special values of Chebyshev polynomials and problems. **Hermite Polynomials:**Hermitedifferential equation and its solution, Hermite polynomial of order *n*, Generating function forHermite polynomials, Alternative expressions for the Hermite polynomials, Rodrigues formula for Hermite polynomials, Hermite polynomials for some special values of *n*, Orthogonality properties of the Hermite polynomials, Recurrence relations and problems. **Laguerre Polynomials:** Laguerre differential equation and its solution, Laguerre polynomial of order *n*, Alternative definition of Laguerre polynomial of order *n*, Generating function for Laguerre polynomials, Alternative expression for the Laguerre polynomials, First few Laguerre polynomials, Orthogonality properties of Laguerre polynomials, Expansion of a polynomial in a series of Laguerre polynomials, Relation between Laguerre polynomial and their derivatives and problems.	

References:

1. G. F. Simmons: Differential Equations with Applications, T.M.H. New Delhi (2002).
2. G. Birkoff and G. C. Rota: Ordinary Differential Equations, Ginn and Co. (1995).
3. E. Kreyszig: Advanced Engineering Mathematics, John Wieley and Sons (2002).
4. J. Cronin: Differential Equations, Marcel and Dekkar (1994).
5. F. Ayers: Theory and Problems of Differential Equations, McGraw Hill (1972).
6. E. A. Coddington: Introduction to Ordinary Differential equations, EEE (1996).
7. I. N. Sneddon: Elements of Partial Differential Equations, McGraw Hill (1999).
8. P. Prasad and R. Ravindran: Partial Differential Equations, Wiley Eastern (1998).
9. D. W. Jordan and P. Smith: Nonlinear Ordinary Differential Equations, Oxford, Indian Edition (1999).

10. S. J. Farlow: Partial Differential Equations for Scientists and Engineers, John Wiley (1998)
11. E. C. Zachmanoglou and Dale W. Thoe: Introduction to Partial Differential Equations with applications, Dover (1996)
12. P. L. Sachdev: Nonlinear Ordinary Differential Equations, Marcel and Dekkar (1998)
13. L. C. Evans: Partial Differential Equations, American Mathematical Society (1998)
14. G. F. Simmons: Differential Equations with Applications and Historical Notes, THM, New
Delhi (2000).
15. M. D. Raisinghania: Ordinary and Partial Differential Equations, S. Chand & Company Pvt. Ltd. (2017).

FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – II

Subject: MATHEMATICS

Open Elective Course (OEC)

(Only for students who are not enrolled in M.Sc. Mathematics Programme)

Course Title: Discrete Mathematical Structures and Differential Calculus

Course Code: A2MAT205T(Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
OEC – 1	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:

CO 1: Understand concept of Mathematical induction.

CO 2: Perform operations on Boolean algebra.

CO 3: Apply counting principle.

CO 4: Understand basic definitions of Graph Theory.

CO 5: Solve tree network problems.

CO 6: Solve problems limits and continuity.

CO 7: Understand mean value theorems.

Unit	**Title:** Discrete Mathematical Structures and Differential Calculus	60 Hours / Sem
Unit – I	**Mathematical Induction and Boolean Algebra:**	15 Hrs.
	Mathematical induction, Permutations and Combinations, Binomial theorem, Set theory – Relations – Functions, Boolean algebra.	
Unit – II	**Graph Theory:**	15 Hrs.
	Introduction to Graph Theory, Basic definitions, Trees, Networks, Algorithms, Euclid’s algorithms, Recursive algorithm, Counting principles, Fibonacci numbers, Pigeonhole principle.	
Unit – III	**Limits and Continuity:**	15 Hrs.
	Limits and continuity, Algebra of limits and continuous functions, Properties of continuous functions, Boundedness of continuous functions, Intermediate value theorem.	
Unit – IV	**Mean Value Theorems:**	15 Hrs.
	Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Taylor's theorem (with Schlomilch and Roache's form of remainder). Maclaurian'sSeries.	

References:

1. K. H. Rosen: Discrete Mathematics and its Applications, McGraw Hill Publications (2021).

2. C. V. Sastry and Rakesh Nayak: A Textbook on Discrete Mathematics, Wiley (2020).

3.B. Kolman,R. Busby and S. C. Ross: Discrete Mathematical Structures, Pearson Edu. India (2015).

4. Rajendra Akerkar and Rupali Akerkar: Discrete Mathematics, Pearson Edu. India (2004).

5.W. Rudin: Principles of Mathematical Analysis,McGraw Hill Edu. (2023).

6. S. C. Malik and Savita Arora: Mathematical Analysis, New Age International Ltd. (2021).

7. S. K. Mapa: Introduction to Real Analysis, Leveant Book Publishers (2022).

8. Shanti Narayan and P. K. Mittal: Differential Calculus, S. Chand & Co.(2022).

9. D. C. Pavate and G. V. Bhagwat: The Elements of Calculus, Popular Prakashan(1956).

10. E. Mendelson: Schaum's Outlines of Calculus, McGraw Hill(2021).

FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – II

Subject: MATHEMATICS

Discipline Specific Core Course (DSC)

Course Title: MATLAB-Programming Lab

Course Code: A2MAT006P (Practical)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 11	Practical	04	08	120 Hrs.	04 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Practical), students will be able to:

CO 1: Learn basics of MATLAB Programming Language.
CO 2: Understand scripts, functions and graphs involved MATLAB programming.
CO 3: Find rank and nullity of a matrix.
CO 4: Find basis and dimension of a vector space.
CO 5: Find the transition matrix from one basis to another basis.
CO 6: Determine the roots of an algebraic equation using various iterative methods.
CO 7: Solve system of linear equations using direct methods, such as Gauss elimination, Jordan and LU decomposition methods.

List of Experiments

1. Program to find angle between two vectors in n-dimensional space and check the orthogonality.
2. Program to find the rank and nullity of a matrix through its row reduced echelon form.
3. Program to check whether the given vector is in the span of a set of vectors.
4. Program to discuss the nature of consistency for system of linear equations.
5. Program to verify the linear dependency of set of vectors.
6. Program to determine whether the system of linear equations $Ax = b$, where A=ones(3,2), b=[1;2;3], possesses an exact solution x.
7. Program to compute and print the basis and dimension of each four fundamental subspaces associated with a matrix.
8. Program to find the coordinate matrix of a vector in a vector space of dimension 4 with respect to some basis.
9. Program to check whether a given vector is orthogonal to column space of a given matrix.
10. Program to compute the transition matrix from one basis (T) to another basis (S).
11. Program to find root of a given equation using Bisection method.
12. Program to find root of a given equation using Regula-falsi method.
13. Program to find root of a given equation using Secant method.
14. Program to find root of a given equation using Newton-Raphson method.
15. Program to find root of a given equation using Fixed-Point iterative method.
16. Program to find the smallest positive root of the equation using Birge-Vieta method.
17. Program to find the roots of a polynomial using Bairstow method.
18. Program to solve the system of linear equations by Gauss-elimination method.
19. Program to solve the system of linear equations by Gauss-Jordan method.
20. Program to solve the system of linear equations by using LU decomposition method.

Instructions

1. Software to be used: MATLAB.

2. During the semester, student should cover up the below mentioned MATLAB programming syllabus in the form of assignments and seminars.

Title: MATLAB-Programming Lab
Introduction and Interactive Computation:
Introduction; Matrices and vectors: Input, Indexing, Matrix manipulation, Creating vectors; Matrix and array operations: Arithmetic, relational and logical operations, Elementary math functions, Matrix functions, Character strings; Creating and using inline functions, Using built-in functions and on-line help; Saving and loading data; Plotting simple graphs.
Scripts, Functions and Graphs:
Script files; Function files: Executing a function, Sub-functions, Compiled functions, The profiler; Use of comments to create on-line help; Global variables; Loops, branches and control flow; Interactive input; Recursion; Input/Output; Multi-dimensional matrices; Structures; Cells; Basic 2D Plots; 3D Plots; Errors; Applications.

References:

1. Rudra Pratap: Getting started with MATLAB, Masood Books UP (2019).
2. B. R. Hunt, R. L. Lipsman and J. M. Rosenberg: A Guide to MATLAB: For Beginners and Experienced Users, Cambridge University Press (2014).
3. S. J. Chapman: MATLAB Programming for Engineers, Cengage India Pvt. Ltd. (2019).
4. R. K. Bansal, A. K. Goel and M. K. Sharma: MATLAB and its Applications in Engineering, Pearson Education India (2016).
5. A. Gilat: MATLAB: An Introduction with Applications, Wiley (2012).
6. S. Eshkabilov: Beginning MATLAB and Simulink, APress (2022).
7. W. Bober, C. Tsai and O. Masory: Numerical and Analytical Methods with MATLAB, CRC Press Inc. (2009).
8. P. Patankar and S. Kulkarni: MATLAB and Simulink in-Depth, BPB Publications (2022).
9. B. Bakariya and K. S. Parmar: Fundamental Concepts of MATLAB Programming, BPB Publications (2020).
10. D. M. Etter: Introduction to MATLAB, Pearson Education (2020).

Scheme of Practical Examination (Distribution of Marks)

FormativeAssessmentforPractical	
AssessmentOccasion /Type	**Marks**
Program writing and problem solving (2 Programs)	(3+3)*2 = 12
Program Execution (2 Programs)	04
Viva	02
Journal	02
Total	**20Marks**
FormativeAssessmentasperguidelines.	

SummativeAssessmentforPractical	
AssessmentOccasion /Type	**Marks**
Program writing and problem solving (2 Programs)	(10+10)*2 = 40
Program Execution (2 Programs)	20
Viva	10
Journal	10
Total	**80Marks**
SummativeAssessmentasperguidelines.	

M.Sc. Semester – III

Subject: MATHEMATICS

Discipline Specific Core Course (DSC)

Course Title: Partial Differential Equations and Numerical Methods

Course Code: A3MAT001T (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 12	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:

CO 1: Derive heat, wave and Laplace equations with various possible solutions.
CO 2: Provide advanced knowledge and good understanding of nature of PDEs like parabolic, elliptic and hyperbolic. .
CO 3: Discuss the working rule for reducing a hyperbolic, parabolic and ellipticequations to its canonicalform.
CO 4: Learn about Riemann method of solution of general linear hyperbolic equation of second order.
CO 5: Solve various problems using single and multi-step methods.
CO 6: Work out on boundary value problems, finite difference methods and shooting method.
CO 7: Work numerically on the partial differential equations using different methods through the theory of finite differences.

Unit	**Title:** Partial Differential Equations and Numerical Methods	60 Hours / Sem
Unit – I	**Applications ofPartial Differential Equations:**	**15 Hrs.**
	Introduction, Derivation of one-dimensional wave equation, Derivation of one-dimensional heat equation, Various possible solutions of standard PDEs by the method of separation of variables, Various possible solution of the one-dimensional wave equation, D'Alembert's solution of the one-dimensional wave equation, Various possible solutions of the one-dimensional heat equation, Various possible solutions of the two-dimensional Laplace's equation.	
Unit – II	**Classification of Partial Differential Equations, Reduction to Canonical or Normal Form, Riemann Method:**	**15 Hrs.**
	Classification of partial differential equation of second order, Classification of partial differential equations in three independent variables and examples, Cauchy’s problem of second orderpartial differential equations and examples, Laplace transformation, Reduction to canonical (or normal) form, Working rule for reducing a hyperbolic, parabolic and ellipticequations to its canonicalform and examples, The solution of linearhyperbolicequations, Riemann method of solution of general linear hyperbolic equation of second order and examples.	

	Riemann-Volterra method of solving Cauchy problem for the one dimensional wave equations. **Cauchy Initial Value Problem For Linear First Order Partial Differential Equations:** The Cauchy problem (Initial Value Problem), Integral surfaces through a given curve, TheCauchy problem, Cauchyinitial value problem for semi-linear partial differential equations, Characteristic curves,Cauchy initial value problem for quasi-linear partial differential equations, The existence and uniqueness theorem for the solution of Cauchy problem for quasi-linear partial differential equation.	
Unit – III	**Numerical Solution of Ordinary Differential Equations:**	**15 Hrs.**
	Initial Value Problems: Numerical solution of ordinary differential equations of first order and first degree – Introduction, Numerical methods for initial value problems, Picard's method, Taylor's series method, Modified Euler's method, Runge-Kutta method of fourth order, Predictor and corrector methods, Milne's method, Adams - Bashforth method, Numerical solution of simultaneous first order ODEs, Picard's method, Runge-Kutta method of fourth order, Numerical solution of second order ODEs by Picard's method and Runge-Kutta method, Milne's method. **Boundary Value Problems:** Introduction, Finite Difference Method, Shooting Method, Weighted Residual Methods, Cubic Spline Method,Finite Element Method:Introduction, Functionals, Base Functions, Methods of Approximation: Rayleigh-Ritz and Galerkin Methods. The Finite Element Method: Finite Element Method for One-dimensional Problems.	
Unit – IV	**Numerical Solutions of Partial differential Equations and Integral Equations:**	**15 Hrs.**
	Partial Differential Equations: Introduction, Classification of PDEs of second order, Finite difference approximation to ordinary and partial derivatives, Numerical solution of a PDE, Numerical solution of the one-dimensional wave equation, Numerical solution of the one-dimensional heat equation, Numerical solution of the Laplace's equation in two dimensions. **Integral Equations:** Introduction, Numerical methods for Fredholm equations; Method of degenerate kernels, Quadrature methods, Cubic spline method.	

References:

1. N. Sneddon: Elements of Partial Differential Equations, McGraw Hill Book company Inc. (2006).
2. L. Debnath: Nonlinear PDE's for Scientists and Engineers, Birkhauser, Boston (2007).
3. F. John: Partial Differential Equations, Springer (1971).
4. F. Treves: Basic Linear Partial Differential Equations, Academic Press (1975).
5. M.G. Smith: Introduction to the Theory of Partial Differential Equations, Van Nostrand (1967).
6. Shankar Rao: Partial Differential Equations, PHI, New Delhi (2006).
7. P. Prasad and R. Ravindran: Partial Differential Equations, Wiley Eastern (1998)
8. S. J. Farlow: Partial Differential Equations for Scientists and Engineers, John Wiley (1998).
9. M. K. Jain, S. R. K. Iyengar and R. K. Jain: Numerical Methods for Scientific and Engineering Computation, Wiley Easter(2001).
10. M. K. Jain: Numerical Solution of Differential Equations, Wiley Eastern (1990).
11. G. D. Smith: Numerical Solution of PDE, Oxford University Press(1998).

12. M. D. Raisinghania: Ordinary and Partial Differential Equations, S. Chand & Company Pvt. Ltd. (2017).
13. S. K. Pundir and R. Pundir: Advanced Partial Differential Equations with Boundary Value Problems, Pragati Prakashan Edu. Pub., Meerut(2010).
14.J. N. Reddy: An Introduction to the Finite Element Method,Tata McGraw-Hill(2010).
15.S. S. Rao: The Finite Element Methods in Engineering, Pergamum Press, New York(1989).
16. S. S. Sastry: Introductory Methods of Numerical Analysis, PHI Learning Pvt. Ltd. Pub. (2010).

FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – III

Subject: MATHEMATICS

Discipline Specific CoreCourse (DSC)

Course Title: Measure Theory and Integration

Course Code: A3MAT002T (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 13	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:

CO 1: Understand measure of a set and measurable sets.
CO 2: Learn Borel sets and their measurability.
CO 3: Understand non-measurable sets.
CO 4: Know measurable functions.
CO 5: Approximate measurable functions by specific functions.
CO 6: Compute Lebesgue integrals.
CO 7: Learn functions of bounded variation.

Unit	**Title:** Measure Theory and Integration	60 Hours / Sem
Unit – I	**Measureable Sets:**	**15 Hrs.**
	Length of sets, Lebesgue outer measure of a set, Outer measure of an interval, Measure of a Cantor set, Lebesgue measurable sets, Properties of measurable sets, Algebra of sets, Borel sets and their measurability, Other properties of measurable sets, Characterization of measurable sets, Non-measurable sets.	
Unit – II	**Measurable Functions:**	**15 Hrs.**
	Introduction, Properties of measurable functions, Step function, Operations on measurable functions, Characteristic function, Simple function, Continuous function, Sets of measure zero, Property almost everywhere, Borel measurable functions, Sequence of functions, Egoroff's Theorem, Structure of measurable functions, Lusin theorem, Frechet theorem, Convergence in measure, Riesz theorem, Cauchy sequence in measure.	
Unit – III	**Lebesgue Integral:**	**15 Hrs.**
	Lebesgue integral of bounded function, Comparison of Riemann integral and Lebesgue integral, Properties of Lebesgue integral for bounded measurable functions, Bounded convergence theorem, Integral of non-negative measurable functions, Fatou's lemma, Monotone convergence theorem, Integrable measurable function, General Lebesgue integral, Lebesgue dominated convergence theorem.	
Unit – IV	**Differentiation and Integration:**	**15 Hrs.**
	Dini derivatives, Lebesgue theorem, Functions of bounded variation, Jordan decomposition theorem, Differentiation of an integral, Lebesgue points and sets, Absolutely continuous functions, Integral of derivative.	

References:

1. H. L. Royden: Real Analysis, MacMillan, New York (1963).
2. P. K. Jain and V. P. Gupta: Lebesgue Measure and Integration, New Age International Publishers, New Delhi(2007).
3. C. Goffman: Real Functions, Holt, Rinehart and Winston Inc. New York (1953).
4. I. K. Rana: An Introduction to Measure and Integration, Narosa Publishing House (1997).
5. G. De Barra: Measure Theory and Integration, Wiley Eastern Ltd. (1981).
6. S. C. Malik and S. Arora: Mathematical Analysis, New Age International Publishers, New Delhi(2020).

FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – III

Subject: MATHEMATICS

Discipline Specific Core Course (DSC)

Course Title: Fluid Mechanics

Course Code: A3MAT003T (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 14	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:

CO 1: Understand fluid and types of fluid.

CO 2: Know the significance of continuity equation.

CO 3: Analyse the general motion of fluid.

CO 4: Discuss the heat conduction equation.

CO 5: DiscussPoiseuille and Coutte flows between two parallel cylinders.

CO 6: Understand laminar Boundary Layer.

CO 7: Know about the concept of boundary layer separation.

Unit	**Title:**Fluid Mechanics	60 Hours / Sem
Unit – I	**Introduction to Fluids:**	15 Hrs.
	Basic concepts of fluids, Types of fluids, Distinction between solids and fluid, Distinction between liquid and gas fluid, Continuum hypothesis, Types of flows, Kinematic of fluids in motion, Methods of describing the fluid motion, Velocity of a fluid particle, Material local and convective derivatives, Acceleration of a fluid particle, Acceleration in Cartesian coordinates, Significance of the equation of continuity, The equation of continuity by Euler's method, The equation of continuity in Cartesian coordinates.	
Unit – II	**Motion of Fluid:**	15 Hrs.
	General motion of a fluid element, Stress & strain components in a real fluid, Relation between stress & strain components, Geometrical interpretation of the components of strain, Thermal conductivity of fluid, Fourier law of heat conduction, Navier-Stoke equation & energy equation, Vorticity equation in viscous flow, Analogy between vorticity equation & heat conduction equation.	

Unit – III	**Poiseuille and Coutte flows:**	**15 Hrs.**
	Poiseuille and Coutte flows between two parallel cylinders, Flow between two co-axial cylinders, Flow through tubes of uniform cross section in the form of circle,annulus, ellipse and equilateral triangles under constant pressure gradients, Viscous flow, Dimensional and model analysis, Dimensionless numbers.	
Unit – IV	**Laminar Boundary Layer:**	**15 Hrs.**
	Laminar Boundary Layer, Prandtl's boundary layer concept, Derivation of two dimensional boundary layer equation for velocity & temperature by order magnitude approach, Boundary layer thickness, Displacement thickness, Energy thickness, Boundary layer flow past a flat plate, Blasius solution, Boundary layer separation.	

References:

1. M. D. Raisinghania: Fluid Dynamics with Complete Hydrodynamics and Boundary Layer Theory, S. Chand & Company Pvt. Ltd. (2014).
2. R. K. Bansal: Fluid Mechanics and Hydraulics Machines, 5th Edition, Laxmi Publications (P) Ltd., New Delhi(1995).
3. W. H. Besaint and A. S. Ramsey: A Treatise of Hydrodynamics, Part II, CBS Publishers, Delhi (1958).
4. G. K. Batchelor: An Introduction to Fluid Mechanics, Foundation Books, New Delhi(1994).
5. F.Chorlton: Text Book of Fluid Dynamics, CBS Publishers, Delhi(1985).
6. A.J.Chorin and A. Marsden: A Mathematical Introduction to Fluid Dynamics, Springer-Verlag, New York(1993).
7. L.D.Landau and E.M. Lipschitz: Fluid Mechanics, Pergamon Press, London(1995).
8. H. Schlichting: Boundary Layer Theory, McGraw Hill Book Company, New York(1979).
9. R.K. Rathy: An Introduction to Fluid Dynamics, Oxford and IBM Publishing Company - New Delhi(1976).
10. A. D. Young: Boundary Layers, AJAA Education Series, Washington DC (1989).
11. S.W. Yuan: Foundations of Fluid Mechanics, Prentice Hall of India Pvt. Ltd., New Delhi(1976).
12. L. Rosenhead: Laminar Boundary Layers, Dover Publications Inc. (1989).
13. Shih-I Pai: Viscous Flow Theory: Laminar Flow - Vol. 1, Von Nostrand Reinhold Inc. U. S. (1957).
14. Chia-shun Yih: Dynamic of Non-homogenous Fluid, McMillan, New York(1965).
15. C.C. Lin: Theory of Hydrodynamics Stability, Cambridge University Press (1966).
16. J. K. Goyal, K. P. Gupta, and A. S. Gupta: Fluid Dynamics and Advanced Hydrodynamics, Pragati Prakashan (2009).

FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – III
Subject: MATHEMATICS
Discipline Specific Elective Course (DSE)
(Students shall select either 1(A) or 1(B) or 1(C))
Course Title: Nevanlinna Theory
Course Code: A3MAT104AT (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE – 1 (A)	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:
CO 1: Understand entire functions.
CO 2: Learn the relation between asymptotic values and various exceptional values.
CO 3: Know about Poisson and Jenson formulas.
CO 4: Apply first fundamental theorem of Nevanlinna.
CO 5: Learn characteristic function of elementary functions.
CO 6: Know about order and type of meromorphic functions.
CO 7: Understand deficient and sharing Values.

Unit	**Title:**Nevanlinna Theory	60 Hours / Sem
Unit – I	**Entire Functions:**	**15 Hrs.**
	Growth of an entire function, Basic properties of entire functions using $M(r, f)$, Order and type of entire functions, Maximum term and rank of an entire function, Asymptotic values, Asymptotic curves, Connection between asymptotic value and various exceptional values.	
Unit – II	**Poisson-Jenson Formulas:**	**15 Hrs.**
	Poision Integral formula, Poisson-Jenson theorem, Jenson's formula and applications, Positive logarithmic function and its properties, Characteristic function, Proximity function, Counting function, Basic properties of characteristic function, Nevanlinna's first fundamental theorem.	
Unit – III	**Characteristic Function of Elementary Functions:**	**15 Hrs.**
	Characteristic function of elementary functions, Characteristic function of a rational function, Relation between characteristic function of $f(z)$ and its other forms, Counting function in terms of integral, Cartan's lemma and its applications, Order and type of meromorphic functions, Proximate order and slowly growing functions.	
Unit – IV	**Deficient and Sharing Values:**	**15 Hrs.**
	Second fundamental theorem of Nevanlinna, Picard's theorem, Borel's theorem, Montel's theorem, Deficient values, Relation between the various exceptional values, Fundamental inequality of deficient values, Sharing values, Five values theorem (Uniqueness theorem).	

References:

1. A. I. Markushevich: Theory of Functions of Complex Variable, Vol. II, Prentice-Hall (1965).
2. A. S. B. Holland: Introduction to the Theory of Entire Functions, Academic Press, New York (1973).
3. C. L. Siegel: Nine Introduction to the Theory of Entire Functions, Academic Press, New York (1973).
4. W. K. Haymen: Meromorphic Functions, Oxford University Press (1964).
5. Yang Lo: Value Distribution Theory, Springer Verlag, Scientific Press (1964).
6. C. C. Yang and H. X. Yi: Uniqueness Theory of Meromorphic Functions, Science Press, Beijing/New York (2003).

FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – III
Subject: MATHEMATICS
Discipline Specific Elective Course (DSE)
(Students shall select either 1(A) or 1(B) or 1(C))
Course Title: Discrete Mathematical Structures
Course Code: A3MAT104BT (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE – 1 (B)	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:
CO 1: Understand Logics and conditional statements.
CO 2: Learn permutations and combinations.
CO 3: Know about paths in relations and digraphs.
CO 4: Understand posets and Hasse diagram.
CO 5: Know about Lattices and their properties.
CO 6: Understand graphs and their types.
CO 7: Analyse characters of a tree.

Unit	**Title:** Discrete Mathematical Structures	60 Hours / Sem
Unit – I	**Logic and Counting:**	**15 Hrs.**
	Logic: Propositions and logical operations, Logical connectives, compound statement, quantifiers, Conditional statements, Truth values, Methods of proof. *Counting:* Permutations, Combinations, Inclusion-exclusion principle, Pigeonhole principle, Elementary probability, Sample, Event, Recurrence relation, Fibonacci sequence.	
Unit – II	**Relations:**	**15 Hrs.**
	Product sets and partition, Relations, Sets arising from relations, Matrix of relations, Digraphs of relations, Paths in relations and digraphs, Properties of relations, Equivalence relations, Complementary relations, Closures, Transitive closure and Warshall's algorithm.	
Unit – III	**Posets, Lattices and Boolean Algebra:**	**15 Hrs.**
	Partially ordered sets (Posets), Hasse diagram, Topological sorting, Isomorphism, Extremal elements of Posets, Lattice, Properties, Types of Lattices, Bounded, Distributive and Complemented Lattices. *Boolean algebra:* Boolean functions and Boolean expressions, Propositional Calculus, Boolean algebra to digital networks and Switching circuits.	
Unit – IV	**Graph Theory:**	**15 Hrs.**
	Graphs, Digraphs, Subgraphs, Types of graphs, Walk and connectedness, Degrees, Complement of a graph, Cut points, Bridges, Blocks, Block graph, Cut-point graphs, Trees, Characterization of tree, Centre and centroids, Connectivity, Edge connectivity, Partitions, Eulerian graphs, Hamiltonian graphs.	

References:

1. C. L. Liu: Elements of Discrete Mathematics, McGraw Hill International(1986).
2. B. Kolman, R. C. Busby and S. Ross: Discrete Mathematical Structures, Prentice Hall of India, New Delhi(1998).
3. J. P. Tremblay and R. Manohar: Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw Hill(1997).
4. F. Harary: Graph Theory, Narosa Publishing House, New Delhi(2001).
5. J. A. Bondy and U. S. R. Murthy: Graph Theory with Applications, McMillan, London (1976)
6. N. Deo: Graph Theory with Applications to Engineering and Computer Sciences, Prentice Hall of India, New Delhi (1979).

FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – III

Subject: MATHEMATICS

Discipline Specific Elective Course (DSE)

(Students shall select either 1(A) or 1(B) or 1(C))

Course Title: Number Theory

Course Code: A3MAT104CT (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE – 1 (C)	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:

CO 1: Understand residue systems and linear congruences.
CO 2: Analyse polynomial congruences.
CO 3: Know about primitive roots.
CO 4: Learn about prime number in detail.
CO 5: Understand quadratic congruences.
CO 6: Apply Euler's partition theorem.
CO 7: Discuss geometric number theory.

Unit	**Title:**Number Theory	60 Hours / Sem
Unit – I	**Linear and Polynomial Congruences:**	**15 Hrs.**
	Basic properties, Residue systems, Linear congruences, Theorems of Fermat and Wilson (Rearsited), The Chinese remainder theorem, Polynomial congruences, Diophantine equations, Arithmetic functions $\varphi(n)$, $d(n)$ and $\sigma(n)$, their multiplicative properties, Mobius inversion formulas.	
Unit – II	**Primitive Roots and Prime Numbers:**	**15 Hrs.**
	Primitive roots: Properties of reduced residue systems, Primitive roots modulo P. *Prime numbers*: Elementary properties of $T(x)$, Tchebychev's Theorem, Some unsolved problems.	
Unit – III	**Quadratic Congruences:**	**15 Hrs.**
	Quadratic congruences: Euler's criterion, Legendre symbol, Quadratic reciprocity low and its applications	
Unit – IV	**Partition Theory and Geometric Number Theory:**	**15 Hrs.**
	Partition theory: Euler's partition theorem, generating functions, Identities between infinite series and products. Geometric Number Theory: Lattic points, Gauss's circle problem. Dirchelets Division problem.	

References:

1. David M. Burton: Elementary Number Theory, McGraw Hill (2023).
2. J. H. Silverman: A Friendly Introduction to Number Theory, Pearson Edu. (2019).
3. G. E. Andrews: Number Theory, Dover Publications Inc. (1994).
4. S. B. Malik: Basic Number Theory, S. Chand (2018).
5. T. M. Apostol: Introduction to Analytic Number Theory, Narosa (1998).
6. P. Shivaramakrishna and C. Vijayakumari: Algebra and Number Theory, Pearson India (2019).
7. Kuldeep Singh: Number Theory Step by Step, Oxford (2020).
8. H. Kishan: Number Theory, Krishna Prakashan Media P. Ltd. (2014).
9. A. K. R. Chaudhuri: Introduction to Number Theory, New Central Book Agency (2009).
10. G. H. Hardy: Some Famous Problems of the Theory of Numbers, Hawk Press (1997).

FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – III

Subject: MATHEMATICS

Open Elective Course (OEC)

(Only for students who are not enrolled in M.Sc. Mathematics Programme)

Course Title: Fuzzy Sets and Numerical Methods

Course Code: A3MAT205T (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
OEC – 2	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:

CO 1: Understand sets and its properties.

CO 2: Discuss mathematical logic and logic connectives.

CO 3: Analyse fuzzy sets and operations on it.

CO 4: Discuss image and inverse image properties of fuzzy sets.

CO 5: Solve problems using Bisection, secant and Newton-Raphson methods.

CO 6: Solve system of equations using direct methods.

CO 7: Solve system of equations using iterative methods.

Unit	**Title:**Fuzzy Sets and Numerical Methods	60 Hours / Sem
Unit – I	**Set Theory:**	**15 Hrs.**
	Set, Union, Intersection, Complementation, Functions, Characteristics functions, Mathematical Logic, Logical connectives, Two valued & three valued logics, Applications.	
Unit – II	**Fuzzy Sets and Fuzzy Logic:**	**15 Hrs.**
	Fuzzy set theory, Operations on fuzzy sets, Functions on fuzzy sets, Image and inverse image properties, Fuzzy logic.	
Unit – III	**Solutions to Algebraic Equations:**	**15 Hrs.**
	Bisection method, Regula-Falsi method, Secant method, Newton-Raphson method, Fixed-point iterative method.	
Unit – IV	**Solutions to System of Linear Equations:**	**15 Hrs.**
	Gauss elimination method, Gauss Jordan method, LU-Decomposition method, Gauss Jacobi method, Gauss Seidel method.	

References:

1. G. J. Klir and Bo Yuan: Fuzzy Sets and Fuzzy Logic: Theory and Applications, Pearson Edu. (2015).
2. A. K. Bhargava: Fuzzy Set Theory, Fuzzy Logic and their Applications, S. Chand & Company (2013).
3. T. J. Ross: Fuzzy Sets and Fuzzy Logic with Engineering Application, Wiley (2021).
4. M. K. Jain, S. R. K. Iyengar and R. K. Jain: Numerical Methods for Scientific and Engineering Computation, Wiley Easter(2001).
5. S. S. Sastry: Introductory Methods of Numerical Analysis, PHI Learning Pvt. Ltd. Pub. (2010).
6. A. Iserles: A First Course in the Numerical Analysis of Differential Equations, Cambridge Texts in Applied Mathematics(2008).
7. R.L. Burden and J.D. Faires: Numerical Analysis, Thomson-Brooks/Cole(1989).
8. S. D. Conte and Carl De Boor: Elementary Numerical Analysis, McGraw Hill(2000).

FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – III
Subject: MATHEMATICS
Discipline Specific Core Course (DSC)
Course Title: MAPLE-Programming Lab
Course Code: A3MAT006P (Practical)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 15	Practical	04	08	120 Hrs.	04 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Practical), students will be able to:
CO 1: Understand the basics of MAPLE programming.
CO 2: Learn algebra and calculus commands in MAPLE programming.
CO 3: Draw 2D and 3D plots.
CO 4: Solve system of linear equations using iterative methods, such as Gauss Jacobi, Seidel and SOR methods.
CO 5: Find the function value using various interpolation methods.
CO 6: Find the integral of a function using various iterative methods.
CO 7: Find the solution of initial value problems using various single and multi-step methods.

List of Experiments

1. Program to solve the system of linear equations by Jacobi iterative method.
2. Program to solve the system of linear equations by Gauss-Seidel method.
3. Program to solve the system of linear equations by SOR method.
4. Program to find the largest eigenvalue and the corresponding eigenvector of the given matrix using Power method.
5. Program to find the value of $y = f(x)$ using Newton's forward interpolation formula.
6. Program to find the value of $y = f(x)$ using Newton's backward interpolation formula.
7. Program to find the value of $y = f(x)$ using Lagrange's interpolation formula.
8. Program to find the value of $y = f(x)$ using Newton's divided difference formula.
9. Program to find integral of a function using Trapezoidal rule.
10. Program to find integral of a function using Simpson's $(1/3)^{rd}$ rule.
11. Program to find integral of a function using Simpson's $(3/8)^{th}$ rule.
12. Program to find integral of a function using Weddle's rule.
13. Program to find integral of a function using Romberg's method.
14. Program to find integral of a function using two-point quadrature formula.
15. Program to find the solution of initial value problem using Taylor's method.
16. Program to find the solution of initial value problem using Euler's method.
17. Program to find the solution of initial value problem using modified Euler's method.
18. Program to find the solution of initial value problem using Runge - Kutta second order method.
19. Program to find the solution of initial value problem using Runge – Kutta fourth order method.
20. Program to find the solution of initial value problem using Milne's predictor – corrector method.

Instructions

1. Software to be used: MAPLE.

2. During the semester, student should cover up the below mentioned MAPLEprogramming syllabus in the form of assignments and seminars.

Title: MAPLE-Programming Lab
Algebra and Data Types:
Introduction; MAPLE as a calculator: Exact arithmetic and basic functions, Floating-point arithmetic; Polynomials and rational functions; Equations; Integers; Trigonometry; Data Types.
Calculus and Graphics:
Defining functions; Composition of functions; Summation and product; Limits; Differentiation; Integration; Taylor and series expansions; 2D and 3D plotting.

References:

1. F. Garvan: The Maple Book, Chapman & Hall/CRC (2001).
2. M. L. Abell and J. P. Braselton: Maple by Example, Elsevier Academic Press (2005).
3. I. Thompson: Understanding Maple, Cambridge University Press (2017).
4. P. E. Fishback: Linear and Nonlinear Programming with Maple, CRC Press (2019).
5. D. Betounes and M. Redfern: Mathematical Computing: An Introduction to Programming using Maple, Springer Verlag (2013).
6. R. A. Nicolaides and N. J. Walkington: Maple: A Comprehensive Introduction, Cambridge University Press (1996).

Scheme of Practical Examination (Distribution of Marks)

FormativeAssessmentforPractical	
AssessmentOccasion /Type	**Marks**
Program writing and problem solving (2 Programs)	(3+3)*2 = 12
Program Execution (2 Programs)	04
Viva	02
Journal	02
Total	**20Marks**
FormativeAssessmentasperguidelines.	

SummativeAssessmentforPractical	
AssessmentOccasion /Type	**Marks**
Program writing and problem solving (2 Programs)	(10+10)*2 = 40
Program Execution (2 Programs)	20
Viva	10
Journal	10
Total	**80Marks**
SummativeAssessmentasperguidelines.	

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M.Sc. Semester – IV

Subject: MATHEMATICS

Discipline Specific Core Course (DSC)

Course Title: Functional Analysis

Course Code: A4MAT001T (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 16	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:

CO 1: Define metric space and norm on metric space.

CO 2: Know about continuous linear transformation of normed linear space.

CO 3: Understand dual space of a normed linear space.

CO 4: Give proof to Hahn-Banach theorem.

CO 5: Learn about canonical embedding of Banach spaces.

CO 6: Understand projection on Banach spaces.

CO 7: Know about Hilbert spaces.

Unit	**Title:** Functional Analysis	60 Hours / Sem
Unit – I	**Banach Space:**	15 Hrs.
	Inequalities, Metric space, Norm on a linear space over F (either R or C), Banach space, Examples, Norm on quotient space. Continuous linear transformation of normed linear space. The Banach space $B(N, N')$ for Banach spaces N, N'.	
Unit – II	**Dual Space:**	15 Hrs.
	Dual space of a normed linear space, Equivalence of norms, Isometric isomorphisms, Hahn-Banach theorem and its applications.	
Unit – III	**Canonical Embedding and Projection on Banach Spaces:**	15 Hrs.
	Canonical embedding of N into N^{**}, Reflexive spaces, Open mapping theorem, Closed graph theorem, Principle of uniform boundedness (Banach-Steinhaus Theorem), Projection on Banach spaces, Inner product space.	
Unit – IV	**Hilbert Spaces:**	15 Hrs.
	Hilbert spaces: definition and examples, Orthogonal complements, Orthonormal basis, Gram-Schmidt process of orthonormalization, Bessel`s inequality, Riesz-Fisher theorem,Adjoint of an operator, Self-adjoint, normal, unitary and projection operator.	

References:

1. G. F. Simmons: Introduction to Topology and Modern Analysis, McGraw Hill Book Com. Inc. (1963).
2. C. Goffman and G. Pedrick: First Course in Functional Analysis, Prentice Hall of India Pvt. Ltd. New Delhi (1974).
3. B. V. Limaye: Functional Analysis, 2nd Edition, New Age International (P) Ltd. Publications (1997).
4. D. Somasundaram: Functional Analysis, S. Vishwanathan Pvt. Ltd. (1994).
5. S. Ponnusamy: Foundations of Functional Analysis, Alpha Science International (2002).
6. H. K. Pathak, Functional analysis with Applications, Shree Shiksha Sahitya Prakashan, 3rd Edition(2022).

FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – IV

Subject: MATHEMATICS

Discipline Specific Core Course (DSC)

Course Title: Fuzzy Topology

Course Code: A4MAT002T (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 17	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:

CO 1: Understand basic definitions and types of fuzzy sets.
CO 2: Learn Zadeh's extension principle.
CO 3: Know about the operations on fuzzy sets.
CO 4: Discuss about arithmetic operations on fuzzy members.
CO 5: Discuss about Multivalued logics, Fuzzy propositions and Fuzzy quantifiers.
CO 6: Convert linguistic variables to fuzzy numbers.
CO 7: Learn Chang's and Lowen's definition of fuzzy topology.

Unit	**Title:**Fuzzy Topology	60 Hours / Sem
Unit – I	**Fuzzy Set Theory:**	**15 Hrs.**
	From classical Sets (crisp sets) to fuzzy sets, Basic definitions, Basic operations on fuzzy sets, Fuzzy sets induced by mappings, Types of fuzzy sets, Fuzzy sets versus Crisp Sets: The α - cuts, strong α - cuts, properties of cuts, representation of fuzzy sets, decomposition theorems, Zadeh's extension principle.	
Unit – II	**Operations on Fuzzy Sets and Fuzzy Arithmetic:**	**15 Hrs.**
	Operations on Fuzzy Sets: Types of operations, Fuzzy complements, Fuzzy intersections, t – norms, Fuzzy unions, t – conorms, Combinations of operations, Aggregation operations. **Fuzzy Arithmetic:** Fuzzy numbers and arithmetic operations on intervals, Arithmetic operations on fuzzy numbers, Fuzzy equations and fuzzy relations, Binary fuzzy relations and binary relations on a single set, Fuzzy equivalence relations.	
Unit – III	**Fuzzy Logic and Fuzzy Decision making:**	**15 Hrs.**
	Fuzzy Logic: An overview of classical logic. Multivalued logics, Fuzzy propositions, Fuzzy quantifiers, Linguistic hedges**.** **Fuzzy Decision making:** Introduction, Conversion of linguistic variables to fuzzy numbers, Individual decision making, Multi person decision making, Multi criteria decision making, Fuzzy ranking methods. Applications of fuzzy sets.	

Unit – IV	**Fuzzy Topology:**	**15 Hrs.**
	Chang's and Lowen's definition of fuzzy topology, Continuity, Open and closed maps. α - shading families, α - connectedness and α - compactness.	

References:

1. S. J. Chen and C. L. Hwang: Fuzzy Multiple Attributes Decision Making, Springer verlag, Berlin Heidelberg (1992).
2. G. J. Klir and B. Yuan: Fuzzy Sets and Fuzzy Logic; Theory and Applications, PHI (1997).
3. A. Kaufmann: Introduction to the Theory of Fuzzy Subsets, Vol. – I, Academic Press (1975).
4. L. Y. Ming and L. M. Kung: Fuzzy Topology, World Scientific Pub. Co. (1997).
5. T. J. Ross: Fuzzy Logic with Engineering Applications, Tata McGraw Hill (1997).
6. H. J. Zimmermann: Fuzzy Set Theory and its Applications, Allied Pub. (1991).
7. N. Palaniappan: Fuzzy Topology, Narosa (2002).

FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – IV

Subject: MATHEMATICS

Discipline Specific Core Course (DSC)

Course Title: Wavelet Theory

Course Code: A4MAT003T (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 18	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:

CO 1: Learn the concepts of Fourier series and Fourier transforms.
CO 2: Understand Eigenvalues and Eigen vectors.
CO 3: Find the solution of homogeneous Fredholm integral equation of the second kind with separable (or Degenerate) kernel.
CO 4: Find the solution of Fredholm integral equation of the second kind by successiveapproximation.
CO 5: Know about geodesics on a plane, geodesics on a surface and hanging cable (chain) problems.
CO 6: Solve the general Haar waveletspace W_j problems.
CO 7: Apply Haar wavelet to find the solution of linear initialvalue problems.

Unit	**Title:** Wavelet Theory	60 Hours / Sem
Unit – I	**Integral Transforms:**	**15 Hrs.**
	Fourier Series: Revision of Fourier series, Fourierseries Harmonic Analysis, Complex form of Fourier series. **Fourier Transforms:** Revision of Fourier Transforms, Convolution, Properties and convolution theorem, Parseval's identities, Fourier transform, Application to the solution of Heat, Wave and Laplace equations.	
Unit – II	**Integral Equations:**	**15 Hrs.**
	Introduction: General definitions, Types of kernels, Eigen values and Eigen function, Differentiation under the sign of integration (Leibnitz's Rule), Connection with differential equation, Solution of an integral equation, Conversion of differential equations to integral equations: Initial value problem, Boundary value problem. **Solution of Fredholm Integral Equations:** Solution of homogeneous Fredholm integral equation of the second kind with separable (or Degenerate) kernel, Orthogonality and reality of Eigen functions, Fredholm integral equation with separable kernel, Solution of the Fredholm integral equation of first kind,Schmidt's solution of the non-homogeneous Fredholm integral equation of second kind.	

	Solution of Integral Equations of Second Kind: Successive Approximation and Substitution Methods: Solution ofFredholm integral equation of the second kind by successive substitution, Solution of Fredholm integral equation of the second kind by successiveapproximation, Solution of Volterra integral equation of the second kind by successive approximation: Neumann series.	
Unit – III	**Calculus of Variations:**	**15 Hrs.**
	Variation of a function, Functionals, Euler's equation, Application of calculus of variations, Geodesics (Definition), Standard variational problems: Geodesics on a plane, Geodesics on a surface, Hanging cable (chain) problem, Brachistochrone problem.	
Unit – IV	**Haar Waveletand Applications:**	**15 Hrs.**
	Haar Spaces: The Haar space V_0 problems, The general Haar space V_j problems, The Haar wavelet space W_0 problems, The general Haar waveletspace W_j problems, Decomposition and reconstruction problems. **The Discrete Haar Wavelet Transform:** The one-dimensional transformproblems, The two-dimensional transformproblems. **Multiresolution Analysis:** Multiresolution analysis problems, The view from the transform domain problems, Examples of multiresolution analyses problems. **Haar Wavelet Application:** Application to the solution of linear initialvalue problems, Linear boundaryvalue problems, Linear integral equations, Linear variational problems.	

References:

1. R. V. Chaurchill: Fourier Series and Boundary Value Problems, McGraw Hill Int. (1990).
2. S. K. Pundir and R. Pundir: Advanced Partial Differential Equations with Boundary Value Problems, Pragati Prakashan Edu. Pub., Meerut (2010).
3. R. P. Kanwal: Linear Integral Equations, Academic Press, New York, (1998).
4. S. K. Pundir and R. Pundir: Integral Equations and Boundary Value Problems, PragatiPrakashan Edu. Pub., Meerut(2010).
5. D. C. Sharma and M. C. Goyal: Integral Equations, PHI Learning, Pvt. Ltd. Pub.(2017).
6. S. J. Farlow: Partial Differential Equations for Scientists and Engineers, John Wiley and Sons(1998).
7. Bruce van Brunt: The Calculus of Variations, Springer-Verlag New York, Inc. (2004).
8. S. K. Pundir and R. Pundir: Calculus of Variations, Pragati Prakashan, Meerut(2010).
9. D. K. Ruch and P. J. Van Fleet: Wavelet Theory, An Elementary Approach with Applications, John Wiley & Sons, Inc., Hoboken, New Jersey, Canada (2009).
10. Ülo Lepik and Helle Hein: Haar Wavelets with Applications, Springer, Int. Pub. Switzerland (2014).
11. Dwight F. Mix and Kraig J. Olejniczak:Elements of Wavelets for Engineers and Scientists,John Wiley & Sons, Inc. (2003).
12. Mani Mehra: Wavelets Theory and Its Applications: A First Course, Springer, SingaporePte Ltd. (2018).
13. Patrick J. Vanfleet: Discrete Wavelet Transformations: An Elementary Approach with Applications, John Wiley & Sons, Inc. (2008).
14. K. Urban: Wavelet Methods for Elliptic Partial Differential Equations, Oxford University Press, Oxford (2009).

15. J. S. Walker: A Primer on Wavelets and their Scientific Applications, Chapman & Hall / CRC Press, Boca Raton, London, New York, Washimgton, D.C. (1999).

FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – IV

Subject: MATHEMATICS

Discipline Specific Elective Course (DSE)

(Students shall select either 2(A) or 2(B) or 2(C))

Course Title: Graph Theory

Course Code: A4MAT104AT (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE – 2 (A)	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:

CO 1: Define graph and analyse its basic properties.
CO 2: Analyse coverings and critical points.
CO 3: Discuss planar graphs and Kuratowski's theorem for planarity.
CO 4: Understand line graphs and their characterizations.
CO 5: Define chromatic number and analyse five color theorem.
CO 6: Define adjacency matrix, incidence matrix and cycle matrix.
CO 7: Understand domination number and automorphism group of graphs.

Unit	**Title:**Graph Theory	60 Hours / Sem
Unit – I	**Introduction Graphs:**	**15 Hrs.**
	Graphs, Basic properties, Types, Operation on graphs, Union, Join, Cartesian product and composition of graphs, Trees, Factorization of a graph, 1-factorization, 2-factorization, Arboricity. Coverings, Vertex covering, Edge covering, Independence number, Matching, Critical points, Matching polynomial.	
Unit – II	**Planar and Line Graphs:**	**15 Hrs.**
	Planarity, Plane and planar graphs, Euler Polyhedron formula, Outer planar graphs, Kuratowski's theorem for planarity.Line graphs, Characterization of line graphs, Subdivision graph, Total graph.	
Unit – III	**Matrices:**	**15 Hrs.**
	Colorability, Chromatic number, Five color theorem, Four color conjecture, Chromatic polynomial. Matrices: Adjacency matrix, Incidence matrix, Cycle matrix, Characteristic polynomial and eigenvalues (Spectra) of graphs, Energy of graphs - Definition and bounds.	
Unit – IV	**Domination Set and Number:**	**15 Hrs.**
	Dominating sets, Domination number, Minimal dominating set, Independent domination set and number, Irredundant set and number. Automorphism group of graphs, Operations on permutation groups, Group of composite graphs.	

References:

1. M. Behzad, G. Chartrand and L. Lesniak-Foster: Graphs and Digraphs, Wadsworth, Belmont(1981).
2. F. Harary: Graph Theory, Narosa Publishing House, New Delhi(2001).
3. J. A. Bondy and U. S. R. Murthy: Graph Theory with Applications, McMillan, London (1976).
4. N. Deo: Graph Theory with Applications to Engineering and Computer Sciences, Prentice Hall of India, New Delhi (1979).
5. D. M. Cvetkovic, M. Doob and H. Sachs: Spectra in Graphs, Academic Press(1980).
6. R. B. Bapat: Graphs and Matrices, Spinger(2010).
7.X. Li, Y. Shi and I. Gutman: Graph Energy, Spinger(2012).
8.R. Balakrishnan and K. Ranganathan: A Text Book on Graph Theory, Springer- Berlin (2019).

FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – IV

Subject: MATHEMATICS

Discipline Specific Elective Course (DSE)

(Students shall select either 2(A) or 2(B) or 2(C))

Course Title: Differential Geometry
Course Code: A4MAT104BT (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE – 2 (B)	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:
CO 1: Understand Euclidean space, Tangent vectors and Vector fields.
CO 2: Find directional derivatives.
CO 3: Obtain dot product in E^3 and dot product of tangent vectors.
CO 4: Understand curvature and torsion of a unit speed curve.
CO 5: Understand arbitrary speed curves and Frenet formulas.
CO 6: Discuss connection forms of a frame field.
CO 7: Discuss normal Curvature, Gaussian curvature, and Special curves in surfaces.

Unit	**Title:**Differential Geometry	60 Hours / Sem
Unit – I	**Mappings on Euclidean Space:**	**15 Hrs.**
	Introduction, Euclidean space, Tangent vectors, Vector fields, Directional derivatives, Curves in E^3. 1 – Forms, Differential forms, Mappings on Euclidean spaces, Derivative map, Dot product in E^3, Dot product of tangent vectors, Frame at a point.	
Unit – II	**Curves in E^3:**	**15 Hrs.**
	Cross product of tangent vectors, Curves in E^3, Arc length, Reparametrization, The Frenet formulas, Frenet frame field, Curvature and torsion of a unit speed curve.	
Unit – III	**Frame Field in E^3:**	**15 Hrs.**
	Arbitrary speed curves, Frenet formulas for arbitrary speed curve, Covariant derivatives, Frame field on E^3, Connection forms of a frame field, Cartan's structural equations.	
Unit – IV	**Mapping of Surfaces:**	**15 Hrs.**
	Calculus on a surface, Co-ordinate patch, Proper patch, Surface in E^3, Monge patch, Patch computations, Parametrization of a cylinder, Differentiable functions and tangent vectors, Tangent to a surface, Tangent plane, Vector-field, Tangent and normal vector-fields on a surface. Mapping of surfaces, Topological properties of surfaces, Manifolds. Shape Operators, Normal curvature, Gaussian curvature, Computational techniques, Special curves in surfaces.	

References:

1. Barrett. O. Neill: Elementary Differential Geometry, Academic Press, New York (1998).
2. T. J. Willmore: An Introduction to Differential Geometry, Oxford University Press (1999).
3. N.J. Hicks: Notes on Differential Geometry, Van Nostrand, Princeton (2000).
4. Nirmala Prakash: Differential Geometry - An Integrated Approach, Tata McGraw Hill Pub. Co. New Delhi (2001).
5. H. K. Pathak and J. P. Chauhan: Differential Geometry, Shree Shiksha Sahitya Prakashan (2018).
6. D. Somasundaram: Differential Geometry, Narosa (2008).

FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – IV

Subject: MATHEMATICS

Discipline Specific Elective Course (DSE)

(Students shall select either 2(A) or 2(B) or 2(C))

Course Title: Classical Mechanics

Course Code: A4MAT104CT (Theory)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE – 2 (C)	Theory	04	04	60 Hrs.	03 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Theory), students will be able to:

CO 1: Understand the basic properties of Cartesian tensors.

CO 2: Learn gradient, divergence and curl in tensor calculus.

CO 3: Know about continuum hypothesis.

CO 4: Discuss decomposition of a deformation.

CO 5: Calculate material and local time derivatives.

CO 6: Understand generalized Hooke's law in different forms.

CO 7: Discuss Navier-Stoke's equations.

Unit	**Title:** Classical Mechanics	60 Hours / Sem
Unit – I	**Tensor Calculus:**	15 Hrs.
	Coordinate transformations, Cartesian tensors, Basic properties, Transpose, Symmetric and skew tensors, Isotropic tensors, Deviatoric tensors, Gradient, Divergence and curl in tensor calculus, Integral theorems.	
Unit – II	**Continuum Hypothesis:**	15 Hrs.
	Continuum hypothesis, Configuration of a continuum, Mass and density, Description ofmotion, Material and spatial coordinates, Translation, Rotation, Deformation of a surfaceelement, Deformation of a volume element, Isochoric deformation, Stretch and rotation,Decomposition of a deformation, Deformation gradient, Strain tensors, Infinitesimal strain, Compatibility relations, Principal strains.	
Unit – III	**Strain and Stress:**	15 Hrs.
	Material and local time derivatives, Strain, Rate tensor, Transport formulas, Stream lines, Path lines, Vorticity and circulation, Stress components and Stress tensors, Normal andshear stresses, Principal stresses, Fundamental basic physical laws, Law of conservation of mass, Principles of linear and angular momentum, Equations of linear elasticity, Generalized Hooke's law in different forms, Physical meanings of elastic moduli.	
Unit – IV	**Viscous and Non-viscous Fluids:**	15 Hrs.
	Navier's equation, Equations of fluid mechanics, Viscous and non-viscous fluids, Stress tensor for a non-viscous fluid, Euler's equations of motion, Equation of motion of an elastic fluid, Bernoulli's equations, Stress tensor for a viscous fluid, Navier-Stokes equation.	

References:

1. D.S. Chandrasekharaiah and L. Debnath: Continuum Mechanics, Academic Press(1994).
2. A.J.M. Spencer: Continuum Mechanics, Longman(1980).
3. Goldstein: Classical Mechanics, Addison – Wesley, 3rd Edition(2001).
4. P. Chadwick: Continuum Mechanics, Allen and Unwin(1976).
5. Y. C. Fung: A First Course in Continuum Mechanics, Prentice Hall(1977).
6. A. S. Ramsey: Dynamics - Part II, The English Language Book Society and Cambridge UniversityPress (1972).
7. F. Gantmacher: Lectures in Analytical Mechanics, MIR Publisher, Mascow (1975).
8. Narayan Chandra Rana and Sharad Chandra Joag: Classical Mechanics, Tata McGraw Hill (1991).
9. F. Chorlton: Text Book of Dynamics, G. Van Nostrand and Co.(1969).

FormativeAssessmentforTheory	
AssessmentOccasion / Type	**Marks**
InternalAssessmentTest1	10
InternalAssessmentTest2	10
Total	**20Marks**
FormativeAssessmentasperguidelines.	

M.Sc. Semester – IV

Subject: MATHEMATICS

Discipline Specific Core Course (DSC)

Course Title: MATHEMATICA-Programming Lab

Course Code: A4MAT005P (Practical)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 19	Practical	04	08	120 Hrs.	04 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Practical), students will be able to:

CO 1: Learn basics of MATHEMATICA programming language.
CO 2: Understand about 2D and 3D graphics.
CO 3: Find root of an equation using various iterative methods.
CO 4: Solve system of linear equations using different direct methods.
CO 5: Solve system of linear equations using different iterative methods.
CO 6: Find the function value using various interpolation formulas.
CO 7: Evaluate the integral value using different numerical techniques.

List of Experiments

1. Program to find root of a given equation using Bisection method.
2. Program to find root of a given equation using Secant method.
3. Program to find root of a given equation using Newton-Raphson method.
4. Program to solve the system of linear equations by Gauss-elimination method.
5. Program to solve the system of linear equations by Gauss-Jordan method.
6. Program to solve the system of linear equations by Jacobi iterative method.
7. Program to solve the system of linear equations by Gauss-Seidel method.
8. Program to find the value of $y = f(x)$ using Newton's forward interpolation formula.
9. Program to find the value of $y = f(x)$ using Lagrange's interpolation formula.
10. Program to find integral of a function using Trapezoidal rule.
11. Program to find integral of a function using Simpson's $(1/3)^{rd}$ rule.
12. Program to find integral of a function using Simpson's $(3/8)^{th}$ rule.
13. Program to find the solution of initial value problem using Taylor's method.
14. Program to find the solution of initial value problem using Euler's method.
15. Program to find the solution of initial value problem using Runge – Kutta fourth order method.
16. Program to solve boundary value problem using Shooting method.
17. Program to solve differential equation by Finite difference method.
18. Program to find solution of initial value problem using Predictor-Corrector method (Milne's/Adam's method).
19. Program to find the numerical solution of heat equation by Crank-Nicolson method.
20. Program to find the numerical solution of wave equation using Finite difference method.

Instructions

1. Software to be used: MATHEMATICA.

2. During the semester, student should cover up the below mentioned MATHEMATICAprogramming syllabus in the form of assignments and seminars.

Title: MATHEMATICA-Programming Lab
Basic Concepts:
Introduction; Constants; Built-in Functions; Basic arithmetic operations; Strings; Assignment and replacement; Logical relations; Sums and Products; Loops; Introduction to Graphing; User-defined functions; Operations on functions.
Lists and Graphics:
Lists: Generating lists; List Manipulation; Set Theory; Tables and matrices. Graphics: Plotting functions of a single variable; Additional graphics commands; Special two-dimensional plots; Animation; Plotting functions of two variables; Other graphics commands; Special three-dimensional plots; Standard shapes-3D graphics primitives.

References:

1. E. Don: Mathematica - Schaum's Outline Series, McGraw Hill Publications (2009).
2. R. Hazrat: Mathematica – A Problem Centered Approach, Springer (2016).
3. P. Wellin: Programming with Mathematica: An Introduction, Cambridge University Press (2013).
4. J. R. Gaylord, S. N. Kamin and P. R. Wellin: Introduction to Programming with Mathematica, Springer-Verlag (1993).
5. M. L. Abell and J. P. Braselton: Mathematica by Example, Academic Press (2016).
6. S. Wolfram: Mathematica Book, Wolfram Media Inc. (2003).
7. C. Kirwan: Mathematica by Example, Manohar Publishers and Distributors (2019).
8. B. F. Torrence and E. A. Torrence: The Student's Introduction to Mathematica, Cambridge University Press (2009).
9. Sandeep Kumar: Practical using Mathematica for Numerical Methods and Analysis – II, Vardhman Publications (2014).

Scheme of Practical Examination (Distribution of Marks)

FormativeAssessmentforPractical	
AssessmentOccasion /Type	**Marks**
Program writing and problem solving (2 Programs)	(3+3)*2 = 12
Program Execution (2 Programs)	04
Viva	02
Journal	02
Total	**20Marks**
FormativeAssessmentasperguidelines.	

SummativeAssessmentforPractical	
AssessmentOccasion /Type	**Marks**
Program writing and problem solving (2 Programs)	(10+10)*2 = 40
Program Execution (2 Programs)	20
Viva	10
Journal	10
Total	**80Marks**
SummativeAssessmentasperguidelines.	

M.Sc. Semester – IV

Subject: MATHEMATICS

Discipline Specific Core Course (DSC)

Course Title: Project Work

Course Code: A4MAT006P (Practical)

Type of Course	Theory /Practical	Credits	Instruction hours per week	Total No. of Lectures / Hours per Semester	Duration of Sem End Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 20	Practical	04	08	120 Hrs.	04 Hrs.	20	80	100

Course Outcomes (COs):

After completion of course (Practical), students will be able to:

CO 1: Typesetting of complex mathematical formulae using LaTeX.

CO 2: Use tabular and array environments within LaTeX.

CO 3: Use various methods to either create or import graphics into a LaTeX document.

CO 4: Typesetting of journal articles, technical reports, and slide presentations using Microsoft word/LaTeX/Power Point Presentation/Beamer, etc.

CO 5: Automatic generation of a table of contents, bibliographies, and indexes.

CO 6: Carryout project work in their interested mathematics concept.

CO 7: Learn various applications of the subjects which they have studied during the entire period of their post-graduation.

Instructions

1. Each student should carry out a **project work** in any concept in Mathematics as per the project guide instructions, wherein, he/she should submit a report each month (For 3 months, Total 3 reports) and at the end of the 14th week of the semester, he/she should submit the dissertation work in the form of a book containing minimum of 60 pages.
2. Dissertation book can be prepared using Microsoft Word or LaTeX software and the presentation can be prepared using Power Point Presentation or Beamer software.
3. Also, during the semester, student should cover up the below mentioned lists of practical and the syllabus in the form of assignments and seminars.

Title: LaTeX and Beamer
LaTeX: Installation of MikeTeX, Online Overleaf access, TEX and its offspring, Creating a Title, Sections, Command names and arguments, Labelling Table of Contents, Font Effects, Coloured Text, Font Sizes, Comments & Spacing Special Characters, Line breaking, Lists, Tables, Figures - List of figures, Equations: Inserting Equations and Mathematical Symbols, Inserting References: Inserting the Bibliography Styles, Technical Report: Writing Thesis/project/report, Classes: article, book, report, beamer, slides. Document Layout and Organization- Page Layout – Titles, Abstract Chapters, Sections, References, Equation References, Citation. List-making environments, Table of contents, Generating new commands, Figure handling numbering, Generating index, Loading packages. Parts of the document: Abstract, Chapters, Appendix, Customized head and foot lines, Page numbering, Paragraph formatting, Single and double column pages.
Beamer: Introduction to Beamer, Main features: How to set the document class to beamer,

its title, subtitle, author, institute, and date information, Bold, italics and underlining, Highlighting important sentences/words, Customizing presentation: themes (rows) and colorthemes (columns), Fonts and columns.

List ofLaTeX Experiments

1. Creating a simple article/document using latex.
2. Write and display Mathematical Equations.
3. Creating table in Different forms.
4. Importing figures into Latex document.
5. Drawing Graphs into Latex document.

List ofBeamer Experiments

1. Creating Lists in presentation.
2. Creating Mathematical Blocks.
3. Creating Mini-Pages.
4. Inserting Tables and Figures in Frames.
5. Creating Bibliography in Frames.

References:

1. G. Gratzer: Practical LaTeX, Springer Nature (2014).
2. H. Kopka and P. W. Daly: Guide to LaTeX, Addison-Wesley Professional (2003).
3. R. Ramalakshmi: LaTeX for Beginners, Jayalakshmi Publications (2023).
4. https://www.overleaf.com/learn/latex/Beamer#Reference_guide
5. https://mirror.niser.ac.in/ctan/macros/latex/contrib/beamer/doc/beameruserguide.pdf
6. Charles T. Batts: A Beamer Tutorial in Beamer. (http://www.ctan.org/texarchive/macros/latex/contrib/beameroc)
7. http:/latex-beamer.sourceforge.net
8. https://bookauthority.org/books/best-latex-books

9.LATEX Tutorials, A PRIMER Indian TEX Users Group Trivandrum, India, 2003.

Scheme of Practical Examination (Distribution of Marks)

FormativeAssessmentforPractical	
AssessmentOccasion /Type	**Marks**
Submission of Two Progress Reports	10*2 = 20
Total	**20Marks**
FormativeAssessmentasperguidelines.	

SummativeAssessmentforPractical	
AssessmentOccasion /Type	**Marks**
Project Report	35
Presentation	25
Viva-voce	20
Total	**80Marks**
SummativeAssessmentasperguidelines.	

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P. G. PROGRAMME: 2024-25

GENERAL PATTERN OF THEORY QUESTION PAPER FOR DSC/ DSE/OEC

(80 Marks for Semester End Examination with3 Hrs Duration)

Note: (i)Answer any FIVE full questions from the following.

(ii)Each question carries equal marks.

- **Question Number 1 – 8:** Each question carries 16 marks (Minimum 2 questions from each unit).

Question Number	Sub-question Number	Marks
1	Left to the Question Paper Setter's Discretion	16
2		16
3		16
4		16
5		16
6		16
7		16
8		16

- **Question Number 9:** Answer any FOUR SHORT NOTES from the following (Minimum 2 short notes from each unit):

Question Number	Sub-question Number	Marks
9	(i)	4 x 4 = 16
	(ii)	
	(iii)	
	(iv)	
	(v)	
	(vi)	
	(vii)	
	(viii)	

Total: 80 Marks

Note: Proportionate weightage shall be given to each unit based on number of hours prescribed.

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