Annexure - III

Faculty of Science

Ordinance, Curriculum & Syllabus

Master of Science (Mathematics)

(2019-20)

Shree Guru Gobind Singh Tricentenary

University, Gurugram (Haryana)-122505, India

MASTER OF SCIENCE [M.Sc.]

COURSE ORDINANCE

1. PREAMBLE

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning process, examination and evaluation systems, besides governance and other matters.

The UGC has formulated various regulations and guidelines from time to time to improve the higher education system and maintain minimum standards and quality across the Higher Educational Institutions (HEIs) in India. The academic reforms recommended by the UGC in the recent past have led to overall improvement in the higher education system.
Faculty of Science. Shree Guru Gobind Singh Tercentenary University, Gurugram with the aim to enhance academic standards in quality of higher education has adopted the UGC guide lines as such in all PG courses.

The grading system is considered to be better than the conventional marks system and in order to facilitate student mobility across institutions with in India and across countries the community grade point average (CGPA) has been introduced in all the PG courses. The guidelines as follows,

CHOICE BASED CREDIT SYSTEM (CBCS):

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

Outline of Choice Based Credit System:

a. **Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

b. **Elective Course:** Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

   i. **Discipline Specific Elective (DSE) Course**: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The

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University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

ii. **Dissertation/Project:** An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

c. **Skill Enhancement Course:** The course based upon the content that leads to Knowledge enhancement.

2. GOALS:

i. Employment prospects for post graduates are very good. The scientific knowledge and mathematical and analytic skills acquired help to place across a wide range of industries including aerospace, pharmaceutical, dyes, fabrics, electronics, semiconductors, petroleum, communications, computing, education, commerce, civil services and many more.

ii. The course will build a rich knowledge base to provide a foundation for the continued study of science.

iii. The theoretical and experimental skills necessary to analyze and solve a range of advances problems, providing an excellent foundation for leadership.

iv. Post-graduation leads to abundance of research opportunities.

3. OBJECTIVES

The postgraduate training should enable the student to:

i. Practice efficiently various investigative procedures backed by scientific knowledge including basic sciences and skills.

ii. Get expertise in his/her field of interest

iii. Play the assigned role in the implementation of required practical skills.

iv. Be a motivated 'teacher' - defined as one keen to share knowledge and skills with a colleague or a junior or any learner continue to evince keen interest in continuing education irrespective of whether he/she is in a teaching institution or is practicing and use appropriate learning resources.

v. Exercise empathy and a caring attitude and maintain professional integrity, honesty and high ethical standards.

vi. The student is expected to know his subject in depth; however, emphasis should be on the analytical techniques. Knowledge of recent advances and basic sciences as applicable to his/her specialty should get high priority.

vii. Competence in skills commensurate with the specialty (actual hands-on training) must be ensured.

4. Duration and Nomenclature of the Course:

The duration of M.Sc (Physics /Chemistry /Mathematics /Forensic Science/Environmental Science course shall be of two academic years consisting of four (4) semesters (15-17 weeks) under Choice Based Credit System(CBCS). On successful completion of all the four semesters, the student will be awarded M.Sc.Degree in the concerned course. The student

shall complete the course within a maximum period of 4 years from the date of admission to the first semester, failing which he/she will be disqualified from the course.

5. **Admission to the Course:**

   i. **Eligibility for Admission:**

   For admission to the 1st Semester of M.Sc. (Physics) course, the candidate must have passed B.Sc. (Pass) with Physics as one of the subjects/B.Sc. (Hons.) Physicswith 50% marks (45% marks in case of SC/ST candidates of Haryana only) in aggregate or equivalent grade from any university recognized by UGC

   For admission to the 1st Semester of M.Sc. (Chemistry) course, the candidate must have passed B.Sc. (Pass) with Chemistry as one of the subjects/B.Sc. (Hons.) Chemistry with 50% marks (45% marks in case of SC/ST candidates of Haryana only) in aggregate or equivalent grade from any university recognized by UGC.

   For admission to the 1st Semester of M.Sc. (Mathematics) course, the candidate must have passed B.Sc. (Pass) with Mathematics as one of the subjects/B.Sc. (Hons.) Mathematics /B.A (Pass) with Mathematics/ as one of the subjects/ B.A (Hons.) Mathematicswith 50% marks (45% marks in case of SC/ST candidates of Haryana only) in aggregate or equivalent grade from any university recognized by UGC.

   For admission to the 1st Semester of M.Sc. (Forensic Science) course, the candidate must be graduate with Physics, Chemistry & Mathematics, Physics, Chemistry & Biology OR Agricultural sciences OR BCA OR B.Pharm. OR B.Sc.(Nursing) OR Engineering sciences OR B.Sc.(Forensic Sciences) OR Medical sciences with 50% marks (45%marks in case of SC/ST candidates of Haryana only) in aggregate or equivalent grade from any university recognized by UGC.

   For admission to the 1st Semester of M.Sc. (Environmental Science) course, the candidate must have passed B.Sc(Non Medical/ Environmental Sciences/Life Sciences/Bio Sciences/ Agriculture) with 50% marks (45% marks in case of SC/ST candidates of Haryana only) in aggregate or equivalent grade from any university recognized by UGC.

   ii. **Schedule of admission and payment of fees:**

   The admission schedule, along with last date for the submission of admission forms and payment of fees, shall be fixed by the Vice-Chancellor from time to time.

6. **Mode of Selection of Candidates for Admission:**

   The admissions will be made as per the following criteria:

Sr.No.	Criteria	Condition
1	On the Basis of the Merit of the qualifying Examination.	If the no. of applicants is up to 3 times of the intake
2	On the Basis of the Merit of the Entrance Examination.	If the no. of applicants is more than 3 times of the intake

7. **Syllabus:**

The syllabus is based on Choice Based Credit System (CBCS) and is recommended by Board of Studies and approved by Academic Council from time to time.

8. Scheme of Examination, distribution of marks, credit system and Syllabus:

The Scheme of examination, distribution of marks in various papers along with the credit system and the syllabus of the course shall be as approved by Board of Studies/Academic Council from time to time.

9. Medium of Instruction and Examination:

The medium of the instruction and the examination shall be English only.

10. Attendance Requirements/Eligibility to Appear in Examination:

The student should fulfill the following criteria to be eligible for appearing in the End Term Semester Examinations:

i. He/she should bear a good moral character.

ii. He/she should be on the rolls of the Dept./Faculty of the University during the semester.

iii. He/she should have 75% of the attendance during the respective semester. Twenty five per cent (25%) of attendance relaxation shall account for illness and contingencies of serious and unavoidable nature.

iv. The Dean of the Faculty of his own or on the recommendation of the HOD shall have the power to give relaxation upto 5% on genuine grounds over the minimum 75% attendance.

v. Further, the Vice Chancellor of his own or on the recommendation of the Dean shall have the power to give further relaxation upto 5% on genuine grounds over the above mentioned minimum attendance.

vi. He/she should not be a defaulter in payment of any dues of the SGT University and no disciplinary action is pending against the student.

11. Exemption from Attendance / Shortage of attendance to be condoned:

The shortage of lecture to the maximum limit as under can be condoned by the competent authority:

Sr. No	Exemptable No. of Lecture	Ground of Exemption	Competent Authority
1	All periods of the days of blood donation	Voluntarily blood donation to the Blood Bank.	Dean of the Faculty
2	All periods of the day of Examination	For appearing in the supplementary examinations(Theory /Practical/Viva-voce)	-do-
3	10 days attendance during a semester	For participation in University or Inter-Collegiate Sports Tournaments/ Youth Festivals, NCC/NSS Camps/University Educational Excursions/ Mountaineering Courses	-do-

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4	15days attendance during a semester	For participation in Inter-University Sports Tournaments/ Youth Festivals	-do-

Provided:

i. that he/she has obtained prior approval of the Dean, Faculty of Science;

ii. that credit may be given only for the days on which lectures were delivered or tutorials or practical work done during the period of participation in the aforesaid events.

12. Attendance Shortage Warning:

Attendance shortage warning will be displayed on the Faculty's Notice Board and University Website by 10th day of every month.

13. Detained students

A student,who does not fulfill the criteria prescribed in Clauses10-11, will not be eligible for appearing in the End Term Semester Examination in that particular paper and will be deemed as Detained in that paper.Such student will repeat the course/paper alongwith the regular students of the subsequent batchto fulfill the prescribed conditions to appear in the "End Term" examination of the course/ paper.

14. Submission of Examination Forms and Payment of Examination Fee:

The Dean, Faculty of Science shall submit the examination admission forms of thosestudents who satisfy the eligibility criteria to appear in the examinations to the Controller of Examinations as per schedule of examination circulated by him from time to time.

15. University Examinations:

i. End Term Semester Examinations:

The examination for the 1st and 3rd semesters (Odd Semesters) shall ordinarily be held in the month of December and of the 2nd and 4th semesters (Even Semesters) in the month of May/June. The examination dates are fixed by the controller of examination with the approval of Vice Chancellor.

ii. Fail/ Reappear candidates:

Fail / re-appear candidate of the odd semesters (1st & 3rd) will take re-appear exams as an ex-student in the subsequent exams of the odd semesters(1st&3rd). Similarly, for the even semesters (2nd&4th), he/she will take re-appear exams. in the subsequent exams of the even semesters (2nd&4th). However, a candidate appearing in the 4th semester examination (Regular) may appear simultaneously in his/her re-appear paper(s) of lower semesters.

16. Improvement Examination:

The student may be permitted to improve his/her result subject to the following conditions:

i. The student will be permitted to appear in improvement examination as an ex-student with regular batches.

ii. The student will be permitted to improve his/her CGPA in one or all papers in which he/she has obtained CGPA less than 'First Division' in aggregate.

iii. Only one chance per paper will be given. The chance must be availed within a year of initially passing of every semester examination.

iv. The candidate will be required to apply and allowed to appear only for theory examinations.

v. If the status/nature of the student's result does not improve by five (05) or more per cent, his/her improvement result will be declared "PRS" (Previous Result Stands).

vi. The candidate shall be allowed to appear in the improvement examination(s) along with regular candidates as and when the course is offered. No separate examination will be held for improvement of result. In case of change of syllabi, the student shall have to appear for improvement in accordance with the changed syllabi of the concerned course applicable to the regular students of that exam.

17. Setting of Question Papers:

i. The Head of the Department/Dean of the Faculty shall supply the panel of internal and external examiners duly approved by the Board of Studies to the Controller of Examinations. The paper(s) will be set by the examiner(s) nominated by the Vice-Chancellor from the panel of examiners.

ii. An examiner shall be allowed to set not more than two papers in a semester examination.

iii. The examiner(s) will set the question papers as per criteria laid down in the Scheme of Examinations as approved by the Board of Studies/Academic Council of the University.

18. Evaluation Process – Theory and Practical:

Evaluation of Answer Books:

The answer books may be evaluated either by the paper setter or any other internal or external examiner to be nominated by the Controller of Examiners with the approval of the Vice-Chancellor from the panel of examiners approved by the Board of Studies.

Re-evaluation of Answer Books:

Re-evaluation/ rechecking of any paper is allowed. The students can apply for Re-evaluation/ Re-checking of any paper to the Controller of Examinations through the HoD/Dean of the Faculty within 10 days of the declaration of result by paying prescribed fee.

Practical Examinations - Appointment of Examiner:

a. The practical examinations shall be conducted by a Board of two Examiners consisting of one internal and one external examiner to be nominated by the Vice-Chancellor from the panel of examiners.

Marks Distribution:

The distribution of marks in examination of the practical paper will be as per the criteria given below:

a. Experimental performance = 60% marks

b. Viva-Voce = 30% marks

c. Laboratory work report = 10% marks

19. External Assessment (Summative Assessment):

Sixty per cent marks shall be assigned to each theory and practical paper as Summative Assessment. The distribution of marks in theory as well as practical papers will be in accordance to IQAC guidelines.

20. Internal Assessment(Formative Assessment):

i. (Theory Papers)

a. Based on 40 Marks:

1	Assignment	5 marks
2	Mid Term Test (10 Marks each)	20 marks
3	Synergy / Project	10 marks
4	Attendance	5 marks
	Marks distribution for Attendance in % age	
	95<=Attendance=100	5 marks
	90<=Attendance<95	4 marks
	85<=Attendance<90	3 marks
	80<=Attendance<85	2 marks
	75<=Attendance<80	1 marks

b. Based on 20 Marks:

1	Assignment	5 marks
2	Mid Term Test	10 marks
3	Attendance	5 marks
	Marks distribution for Attendance in % age	
	95<=Attendance=100	5 marks
	90<=Attendance<95	4 marks
	85<=Attendance<90	3 marks
	80<=Attendance<85	2 marks
	75<=Attendance<80	1 marks

ii. (Practical/Project/Dissertation)

i. Based on 40 Marks:

S.no.	40 Marks Internal		60 Marks External
1	Attendance	10 marks	
2	Practical/Project	10 marks	

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	File/Dissertation		30 marks for Practical examination (Conduction/ Demonstration)/Project File/Dissertation + 30 marks for Viva-Voce in End-term Examination by External Experts.
3	Internal Viva-Voce	20 marks	
	Marks distribution for Attendance in % age		
	97.5<=Attendance=100	10 marks	
	95<=Attendance<97.5	9 marks	
	92.5<=Attendance<95	8 marks	
	90<=Attendance<92.5	7 marks	
	87.5<=Attendance<90	6 marks	
	85<=Attendance<87.5	5 marks	
	82.5<=Attendance<85	4 marks	
	80<=Attendance<82.5	3 marks	
	77.5<=Attendance<80	2 marks	
	75<=Attendance<77.5	1 Marks	

ii. Based on 20 Marks:

s.no.	20 Marks Internal		30 Marks External
1	Attendance	5 marks	15 marks for Practical examination (Conduction/ Demonstration)/Project file/Dissertation + 15 marks for Viva-Voce in End-term Examination by External Experts.
2	Practical/Project File/Dissertation	5 marks	
3	Internal Viva-Voce	10 marks	
	Marks distribution for Attendance in % age		
	95<=Attendance=100	5 marks	
	90<=Attendance<95	4 marks	
	85<=Attendance<90	3 marks	
	80<=Attendance<85	2 marks	
	75<=Attendance<80	1 Marks	

iii. In case of ex-students, those appearing for re-appear / improvement examination in any semester, their previous Internal Assessment marks will be counted.If there is any change in Scheme of Examination, then Internal Assessment marks will be modified accordingly.

iv. The concerned teacher shall preserve records on the basis of which the Internal Assessment has been awarded and shall make the same available to the Controller of Examinations whenever required.

v. The Head of the Department/ Dean of the Faculty shall ensure:

a. That the internal assessment marks are displayed for information of the students at least seven (07) days before the commencement of the examinations of each semester

b. That the internal assessment marks are submitted to the Controller of Examinations at least seven (07) days before the commencement of the examinations of each semester.

21. Criteria for Promotion to Higher Semester:

The student shall be promoted to 2nd and 4th semester automatically without any condition of passing minimum number of papers. For promotion from 2ndto 3rd Semester, the student shall have to clear at least 50% papers of 1st and 2nd semesters taken together.

22. Credit Based Grading System:

i. Key Definitions:

Programme	An educational programme leading to award of a Degree, Diploma or Certificate.
Course	Usually referred to as 'paper' is a component of a programme. All courses need not carry the same weight.
Credit	A unit by which the course work is measured. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours for practical work/field work per week. A Research Based Paper /Project is equal to 6 credits.
Credit Point	It is the product of grade point and number of credits for a course i.e. Credit Point = No. of credits in a course X "grade value" of the grade obtained in the course.
Grade Point	There are two types of GPAs as given hereunder:
Average (GPA)	Semester Grade Point Average (SGPA) Cumulative Grade Point Average (CGPA) Every student earns a distinct SGPA and a distinct CGPA at the end of each specified semester.
SGPA	SGPA is a measure for performance of student in a Semester. It is the Point Average ratio of sum of the product of number of credits with the grade points scored by the student in all the courses taken by him/her and the sum of the number of credits of all the Courses undergone by the student i.e. SGPA (Si) =∑(CixGi) /∑Ci
CGPA	CGPA is a measure of performance up to any Grade Gradespecified semester Point Average beginning from the first Semester. It is also calculated in the same (CGPA) manner as SPGA taking into account all the courses undergone by a student over all the semesters of programme i.e. CGPA = ∑(Cix Si) / ∑Ci
Grade Point	Itis a numerical weight allotted to each letter grade on a 10-point scale.
Letter Grades	It is an index of the performance of a student in a said course. The Grades are denoted by letters O, A+, A, B+, B, C, P, F and Ab.

ii. Credits, Semesters, Courses and total Credit Points:

S.No	Course	Semesters	Core Courses	Discipline Specific elective Courses	Skill Enhancement Courses	Total Credits
1	M.Sc.(Physics)	4	72	16	12	100
2	M.Sc.(Chemistry)	4	74	12	14	100
3	M.Sc.(Mathematics)	4	78	12	10	100
5	M.Sc.(Forensic Sciences)	4	86	8	6	100
6	M.Sc.(Environmental Science)	4	60	24	16	100

Grading Table

Range of Percentage of Marks	Letter Grade	Grade Points	Range of Grade Points	Classification
90 and above	O (Outstanding)	10	9-10	Outstanding
80 & above but less than 90	A+ (Excellent)	9	8< 9	Excellent
70 & above but less than 80	A (Very Good)	8	7< 8	1st Div with Distinction
60 & above but less than 70	B+ (Good)	7	6< 7	1st Division
50 & above but less than 60	B (Above Average)	6	5<6	2nd Division
Above 40 but less than 50	C (Pass Average)	5	Above 4 <5	3rd Division
40	P(Pass)	4	4	Pass
Less than 40	F (Fail)	0	-	Fail

Formula for Calculating percentage of marks:

CGPA× 10 e.g. 6.53× 10 = 65.3

Formula for Grade Point calculation:

G = (Marks Obtained in Paper/Total marks of paper) x100.

Formula for Computation SGPA & CGPA

i. The SGPA is the ratio of sum of the product of the number of credits with the grad points scored by a student in all the courses taken by a students and the sum of the number of credits of all the courses taken by the students;

i.e SGPA (Si) = $\sum(Ci \times Gi) / \sum Ci$,

where Ci is the no of credits of the ith course and Gi is the grad point Scored by the student in the ith course

ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by the students over all the students over all the semesters of a programme , i.e

$$CGPA = \sum(Ci \times Si) / \sum Ci$$

where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

iii. The SGPA and CGPA shall be rounded up to 2 decimal points and reported in the transcripts. Result–Cum-Detailed Marks Card/ Transcript: Based on the above recommendations on letter grades, grade points and SGPA and CGPA, the DMC/ Transcript for each semester and a consolidated transcript in dictating the performance in all semester may be issued

iv. **1. Illustration of Computation of SGPA and CGPA and Format for Transcripts**

Course	Credit	Grade Letter	Grade Point	Credit Points (Credit × *Grad*)
Course 1	3	A	8	3×8 = 24
Course 2	4	B +	7	4×7 = 28
Course 3	3	B	6	3×6 = 18
Course 4	3	O	10	3×10 = 30
Course 5	3	C	5	3×5 = 15
Course 6	4	B	6	4×6 = 24
	20			**139**

Thus, SGPA = 139/20 = 6.95

Similarly, Suppose the SGPA for 2nd , 3rd and 4th semester are 7.85 , 5.6, and 6.0 with credits 22, 24 and 22, respectively, then for a two-year PG Programme, the CGPA will be computed as followed,

CGPA = (20× 6.95 + 22 × 7.85 + 24 × 5.6 + 22 × 6.0)/88 = 6.57

Course	Credits	Grade Letter	Grad Point Block	Range of Grad Points(Actual Grade Value as per marks obtained	Earned Credit Point(Credit × Actual *Grade Value*)
Course 1	3	O	10	9.2	3×9.2=27.6
Course 2	3	A+	9	8.2	3×8.2=24.6
Course 3	4	A	8	7	4×7=28
Course 4	3	B+	7	6.7	3×6.7=27.6
Course 5	3	B	6	5.6	3×5.6=16.8
Course 6	4	C	5	4.7	4×4.7=18.8
	20				**135.9**

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Thus, SGPA= 135.9/20 = 6.79

Similarly suppose SGPA for 2nd , 3rd , and 4th semester are 7.85, 5.6 and 6.0 with credits 22, 24, and 22 respectively

CGPA = (20× 6.79 + 22 × 7.85 + 24 × 5.6 + 22 × 6.0)/88 = 6.53

Calculating percentage of marks

CGPA× 10 E.G.6.53× 10 = 65.3

23. Pass criteria:

The minimum percentage of marks to pass the examination in each subject/paper will be 40% each in theory paper, practical /field work/Research Project etc. examination & internal assessment. The student has to pass in summative and formative (Internal) assessment separately.

24. Declaration of Results:

i. The Controller of Examinations shall declare the results as early as possible after the conclusion of each examination, but before the start of teaching for the next academic session.

ii. Each successful student/ the student placed in reappear shall receive a copy of the Detailed Marks Certificate/ Grade Card Sheet of each semester examination.

iii. The student whose result is declared late without any fault on his/her part may attend classes for the next higher semester provisionally at his /her own risk and responsibility, subject to his /her passing the concerned semester examination. In case, the student fails to pass the concerned semester examination, his/her attendance/internal assessment in the next higher semester in which he / she was allowed to attend classes provisionally will stand cancelled.

25. Other Provisions:

i. Nothing in the Ordinance shall debar the University from amending the Ordinance and the same shall be applicable to all the students whether old or new.

ii. Any other provision not contained in the Ordinance shall be governed by the rules and regulations framed by the University from time to time.

iii. In case of any dispute, the Vice-Chancellor will be competent authority to interpret the rules and his interpretation shall be final.

UNIVERSITYS' COMMON COURSE ORDINANCE POSTGRADUATE & UNDERGRADUATE PROGRAMS

1. Preamble:

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of the country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning (online & offline) process, examination and evaluation systems, besides governance and other matters.

The UGC has formulated various regulations and guidelines from time to time to improve the higher education system and maintain minimum standards and quality across the Higher Educational Institutions (HEIs) in India. The academic reforms recommended by the UGC in the recent past have led to overall improvement in the higher education system.

Department of Mathematic, Faculty of Science, Shree Guru Gobind Singh Tricentenary University, Gurugram with the aim to enhance academic standards in quality of higher education has adopted the UGC guidelines in its Postgraduate (PG) program (M. Sc. Mathematics).

The grading system is considered to be better than the conventional marks system and in order to facilitate student mobility across institutions within India and across countries the community grade point average (CGPA) has been introduced in this PG program. The guidelines are as follows:

CHOICE BASED CREDIT SYSTEM (CBCS):

The CBCS provides an opportunity for the students to choose courses from the prescribed pool of courses comprising core, elective, skill and ability enhancement courses. The courses can be evaluated uniform grading system in the higher education system. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

Outline of Choice Based Credit System:

a. **Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

b. **Elective Course:** Generally, a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

   i. **Discipline Specific Elective (DSE) Course**: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

   ii. **Dissertation/Project:** An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

c. **Skill Enhancement Course:** The course based upon the content that leads to Knowledge enhancement.

d. **Ability Enhancement Compulsory Course:** The course based upon the content that leads to development professional of ability.

e. **Open Elective Course:** The course based upon the content that enhances interdisciplinary knowledge.

2. Justification/Score of the Course:

Mathematics is advancing at spectacular rate and it is about logical analysis, decision making, deductions, precision and is also about quantity, space, change and structure. Mathematics has a pervasive influence on our day to day life, and contributes to the wealth of the society. The structure of curriculum is designed using time tested and Internationally well-known books and is also based on the feedback from the best programmes available in our country. The curriculum consists different branches of mathematics that have a wide range of practical applications such as Algebra, Analysis, Mathematical Modeling, Computer Programming, Mathematical Statistics and Operation Research. The curriculum is so developed that the study of mathematics can satisfy a wide range of interests and abilities.

Those who qualify in M.Sc. Mathematics are in fortunate position of having a wide range of career choices. The abilities to use logical thought, to make deduction from assumption, to use advanced

concepts are all enhanced by a Mathematics degree course. It is for this reason that Mathematicians are increasingly in demand. With M.Sc. Mathematics degree, one should be able to turn his/her hand to Finance, Statistics, Engineering, Computers, Teaching or Accountancy with a success not possible to other post graduates.

3. Duration of the Course:

Name of the Programme	Duration
Master of Science (Mathematics)	02 Years (04 Semesters)

4. Admission to the Course:

(a) Name of the Degree: Master of Science (Mathematics)

(b) Eligibility for Admission:

Name of the Programme	Eligibility
Master of Science (Mathematics)	For admission to the 1st Semester of M.Sc. (Mathematics) course, the candidate must have passed B.Sc. (Non-Medical) /B.Sc.(H) in Mathematics with 50% marks (45% marks in case of SC/ST candidates of Haryana only) in aggregate or equivalent grade from any university recognized by UGC.

Migration/Lateral entry admission in second year/third semester of an academic programme, wherever permitted, shall be considered on the basis of merit in the qualifying examination and subject to the availability of seats in the academic programme where admission is desired. Student who ever granted lateral entry admission is required to pay the requisite fee as admissible to the fresh batch.

(c) Migration Admission:

A student of any other University/Institute/College, recognized by the concerned regulatory/statutory body like UGC etc., shall be eligible for migration (admission) to the University. Migration will be allowed, if the seat is available in thatprogrammeand cannot be claimed as a right by the candidate. Migration can only be allowed, if the student studied the programme in regular mode and is not having any backlog.

In addition to the Application Form for admission, student has to provide the following documents "

(i) Marksheets/result of all the examinations passed.

(ii) Detailed syllabi for all the courses studies till date.

(iii) The migration Certificate and Character Certificate stating that no disciplinary/academic action has been taken or pending.

(iv) All other relevant documents which are required for admission in the programme in which migration is sought.

Studies and Examinations passed by the candidate are recognized as equivalent to the corresponding examination of the University and he fulfills the minimum qualification and other eligibility laid down for admission to the programme to which he/she seeks migration in the University.

The migration case will be submitted to the University Equivalency Committee to verify all the relevant records and candidate will be admitted on the recommendations of the Committee only.

(d) **Student Exchange and Credit Transfer**

For a student exchange from or to a University, credit transfer from or to a University is possible only when there is an academic tie-up with the University and mutually agreed student exchange and credit transfer policy is approved by the Academic council. Student under the exchange programme shall not be considered as migrated.

The University may enter into collaboration with other Universities worldwide whereby students of those Universities can spent a semester or more at SGT University and study courses, accordingly to mutually agreed guidelines. Such students will be known as Associate Students of SGT University for the duration they spend at SGT University and will be governed for all academic matters of the University. Reciprocally, SGT University students may be permitted to spend a semester or more and study courses in collaborating Universities with or without transfer of credits.

(e) Schedule of admission and payment of fees:

The admission schedule, along with last date for the submission of admission forms and payment of fees, shall be fixed and notified by the Registrar with the approval of the Vice-Chancellor from time to time duly approved by the Academic Council/Board of Management of the University.

Students detained due to shortage of attendance and re-admitted will attend regular classes with alternative batch and will be required to pay the Tuition Fee and Examination Fee and make over the attendance criteria as prescribed in the Ordinance. However, ex-students will be exempted from making up the deficiencies of the attendance criteria.

5. Mode of Selection of Candidates for Admission:

On the basis of the merit of the qualifying examination or as per the guidelines of the Statutory Bodies/Haryana Private Universities Act, 2006 as amended from time to time.

6. Medium of Instructions:

The medium of the instruction and the examination shall be English only.

7. University Examinations:

(a) **End Term Semester Examinations:**

The examination for all the Odd Semesters shall ordinarily be held in the month of November/December and of the Even Semesters in the month of May/June.

Fail/re-appear candidates of the Odd Semesters will re-appear in exams as an ex-student in the subsequent exams of the Odd Semesters. Similarly, for the Even Semesters he/she will re-appear in exams in the subsequent exams of the Even Semesters. However, candidates appearing in the Final Semester examination (Regular) may appear simultaneously in his/her re-appear paper(s) of lower semesters i.e. previous semesters as arranged by the Controller of Examinations.

(b) **Scheme of the Examinations/Distribution of Marks:**

The Scheme of examination, distribution of marks in various papers along with the credit system and the syllabus of the course shall be as prepared by the respective Board of Studies of the Faculty and duly approved by the Academic Council of the University from time to time.

(d) **Attendance Requirements/Eligibility to Appear in Examination:**

The student should fulfill the following criteria to be eligible for appearing in the End Term Semester Examination:

(i) He/she should have 75% attendance during the respective semester in each subject which is mandatory. Only 5% relaxation in the required attendance on account of illness and other contingencies by the Dean/Principal may be condoned. Further, the Vice Chancellor may also condone additional 5% of the required attendance in an extreme emergency case on merit basis. The relaxation of the attendance by the Dean/Principal/Vice Chancellor cannot be claimed as a matter of right by the students; it shall depend on facts and circumstances of individual case.

If a student does not meet the attendance criteria as mentioned above, he/she will not be permitted to appear in the End Term Examination. He/she can appear in the subsequent Odd/Even Semester examination after making up the deficiencies in the attendance.

(ii) He/she is not a defaulter in payment of any dues of the SGT University

(iii) No disciplinary action is pending against the student.

(iv) He/she should be on the rolls of the Faculty/College during the semester.

(v) The shortage of attendancecan be condoned by the competent authority as mentioned below in the table to the maximum limit and the same will be within the limit of the attendance criteria as mentioned in Point No. (i) above :

Sr. No	Exemptible attendance	Ground of Exemption	Dean of the Faculty is competent authority to condone shortage of lecture/ attendance.
1.	5%	For illness and contingencies of serious nature by the Dean & the Vice Chancellor	
2.	All periods of the day of donation	Voluntary blood donation to the Blood Bank.	
3.	All periods of the day of Examination.	For appearing in the supplementary examinations (Theory /Practical/Viva-voce	
4.	Maximum of 10 days attendance during a semester	For participation in University or Inter-Collegiate Sports Tournaments/ Youth Festivals, NCC/NSS Camps/University Educational Excursions, Mountaineering Courses	
5.	Maximum of 15 days attendance during a semester	For participation in Inter-University Sports Tournaments/Youth Festivals/Exhibition/ Symposium	

Provided that :

(i) He/she has obtained prior approval of the Dean of the Faculty.

(ii) Credit may be given only for the days on which lectures were delivered or tutorials or practical work done during the period of participation in the aforesaid events.

(e) **Attendance Shortage Warning:**

Attendance shortage warning will be regularly displayed on the Faculty's Notice Board every month and shall also be informed to the parents/guardians by the respective Course Coordinator.

In case, a student falls short of attendance during any semester, his result will be marked as "DETAINED" which can be removed subsequently after completing attendance requirement.

(e) **Submission of Examination Forms:**

All the students are required to submit their Examination Form through University ERP only before the last date as notified by the Controller of Examinations. The Examination Forms of the eligible students shall be validated by the Dean and will be forwarded to the Controller of Examinations within the prescribed date. In case, examination form is not submitted by scheduled last date, a late fee will be charged as prescribed by the University from time to time.

8. Setting of Question Papers:

The Dean of the Faculty shall supply the panel of internal and external examiners duly approved by the Board of Studies to the Controller of Examinations. The paper(s) will be set by the examiner(s) nominated by the Vice-Chancellor from the panel of examiners.

The question papers will be moderated by the Moderation Committee in the Chairmanship of Dean/Principal of the Faculty/College who is proficient in the subject in the office of the Controller of Examinations. The moderation will be done to see the difficulty level and that no question is out of syllabus and there is no mistake in the questions and the committee will amend/correct the paper accordingly.

The examiner(s) will set the question papers as per the criteria laid down in the Scheme of Examinations as approved by the Board of Studies/Academic Council.

9. Appointment of Examiners:

The examiners will be appointed as per the following guidelines with the approval of the Vice Chancellor by taking due care that his/her own relative is not appearing in the examination :

(a) An internal/external examiner should be of the level of an Assistant Professor/consultant/equivalent or above in the respective subject in a University/Institution/College/Hospital.

(b) One external and one internal examiner will jointly conduct the practical examination.

(c) External examiners shall not be from the same University and should preferably be from outside the University.

(d) External examiners shall be rotated at an interval of 3 years.

10. Evaluation Process – Theory, Practical & Internal Assessment:

(a) Evaluation of Answer Books:

The answer books may be evaluated either by the paper setter or any other internal or external examiner to be nominated by the Controller of Examinations with the approval of the Vice-Chancellor from the panel of examiners approved by the Board of Studies.

(b) Re-evaluation of Answer Books:

The students can apply for Re-evaluation/Re-checking of any paper through the HOD/Dean of the Faculty by paying fee as per re-evaluation rules of the university.

(c) Internal/Formative Assessment:

Formative assessment in each theory paper shall have the following distribution:

(i) Attendance = 5 Marks

75 to 80	01
Above 80 to 85	02
Above 85 to 90	03
Above 90 to 95	04
Above 95 to 100	05

(ii) Midterm Class Tests (subjective & objective) = 20 marks

(iii) Assignment = 05 marks

(iv) Problems/Projects/Seminar/Case Studyetc = 10 marks

The concerned teacher shall make continual assessment weekly over the content covered during the week and also shall have record of the same. It shall preferably be displayed monthly and finally cumulatively before the start of the semester examination.**In case, any student fails to clear the Internal Examination, the Vice Chancellor may relax and permit for Re-examination considering the request of the student on merit with the recommendations of the respective Deans.**

(i) In case of ex-students, those appearing for re-appear/improvement examination in any semester, their previous Internal Assessment marks will be counted.

(ii) The concerned teacher shall submit records to the HoD/Dean on the basis of which the Internal Assessment has been awarded and HoD/Dean shall make the same available to the Controller of Examinations whenever required.

(iii) That the internal assessment marks are submitted tothe Controller of Examinations at least 7 (seven) days before the commencement of the end-term examinations of each semester.

(d) Practical Examinations:

(i) **Appointment of Examiners:**

The practical examinations shall be conducted by a Board of two Examiners consisting of one internal and one external examiner to be nominated by the Vice-Chancellor from the panel of examiners recommended by the Board of Studies.

(ii) **Distribution of Marks**: Practical examination for summative examination in all semesters will have the following distribution:

(aa) Summative assessment distribution (30 Marks):

Demonstration/conduction/presentation	=	20 marks
Viva Voce examination	=	10 marks

(ab) Formative assessment distribution (20 Marks):

Attendance = 5 marks

75 to 80	01
Above 80 to 85	02
Above 85 to 90	03
Above 90 to 95	04
Above 95 to 100	05

Laboratory work report	=	5 marks
Midterm oral examination/assessment	=	10 marks

(e) Project:

(i) Topic Selection and Appointment of Guide/Supervisor

Each student will be assigned a Teacher as Guide/ Supervisor from the Department. Topic of the Project will be approved by the Dean of the respective Faculty on the recommendations of the Teacher Guide/supervisor.

(ii) Evaluation:

The examination for Project shall be conducted by a Board of Two Examiners consisting of one internal and one external examiner to be nominated by the Vice-Chancellor from the panel of examiners recommended by the Board of Studies. Evaluation of the Project Report will be done by the External examiner or by Internal Examiner. The student will submit the project report in the form as specified by the department atleastbefore 15 days before the commencement of the examination, failing which it will be acceptable only with late fee of Rs. 2000/-
.

(f) Field Training

Evaluation of the field training will be for the marks as prescribed in the Scheme of Examinations of the respective course/program. The formative assessment of field training shall be based on the presentation, case reports and log sheets as well as on the basis of viva voce and reports adjudged by the joint board of external and/or internal examiners.

(g) Re-appearance for Improvement:

A student may re-appear in any theory paper prescribed for a semester after making the prescribed Examination Fee as notified by the University from time to time, on foregoing in writing his/her previous performance in the paper/s concerned. This can be done in the immediate subsequent semester examination only (for example, a student re-appearing in paper prescribed for 1stSemester examination may do so along with subsequent 3rdSemester examination and shall not be allowed to appear along with papers for 5thSemester.

A candidate who had cleared examination of Third Academic Year (Vth and VIth Semesters) may re-appear in any paper of Vth and VIth Semester only once at the immediate subsequent examinations on foregoing in writing her/her previous performance in the paper/s concerned, within the prescribed span period. Likewise will be applicable for the Fourth Academic Year also.

In the case of re-appearance in paper, the result will be prepared on the basis of candidate's current performance in the examination.

In the case of a candidate, who opts to re-appear in any paper/s under the aforesaid provisions,, on surrendering her/his earlier performance but fails to re-appear in the paper/s concerned, the marks previously secured by the candidate in the paper/s in which he/she has failed to re-appear shall be taken into account while determining his/her result of the examination held currently.

11. Criteria for Promotion to Higher Semester(s):

(a) **For programs of the duration of 4 Academic Years (8 Semesters).**

The student will be promoted to the next semesters irrespective of the number of papers cleared/passed in the lower semesters. But he/she will not be allowed to appear in the examination of the 4th Semester unless he/she has cleared atleast 50% papers of 1st and 2nd semesters taken together and further the students will not be allowed to appear in the examination of the 6th semester unless he/she has cleared 1st and 2nd semesters and 50% papers of 3rd and 4th semesters taken together. Furthermore, the students will not be allowed to appear in the examination of the 8th semester unless he/she cleared 1st, 2nd, 3rd and 4th semesters and 50% papers of 5th and 6th semesters taken together.

(b) **For programs of the duration of 3 Academic Years (6 Semesters).**

The student will be promoted to the next semesters irrespective of the number of papers cleared/passed in the lower semesters. But he/she will not be allowed to appear in the examination of the 4th Semester unless he/she has cleared atleast 50% papers of 1st and 2nd semesters taken together and further the students will not be allowed to appear in the examination of the 6th semester unless he/she has cleared 1st and 2nd semesters and 50% papers of 3rd and 4th semesters taken together.

(c) **For program of the duration of 2 Academic Years (4 Semesters).**

The student will be promoted to the next semesters irrespective of the number of papers cleared/passed in the lower semesters. But he/she will not be allowed to appear in the examination of the 4th Semester unless he/she has cleared 50% subjects of 1st and 2nd semesters taken together.

12. Pass % criteria and grading system:

(a) The minimum percentage of marks to pass a course/paper will be as given below. Each Faculty is required to adopt any one scheme out of the below mentioned and incorporate the same in their respective Scheme of Examinations.

(i) The pass percentage for each component i.e. End Term Examination (Theory/Practical) and Internal Assessment is 40% separately (for the courses adopting Table No. 3).

(ii) The pass percentage for Internal Assessment will be 40% to be eligible to appear in End Term Examination, whereas overall pass percentage will be 50%in the End Term Examination (Theory/Practical) including Internal Assessment (For all other courses) (for the courses adopting Table No. 1).

(iii) The pass percentage for each component i.e. End Term Examination (Theory/Practical) and Internal Assessment is 40% separately (for the courses adopting Table No. 2).

(iv) To qualify for award of degree, a Grade Point of 4.0, 5.0 and 6.0 respectively and minimum numbers of credits required for that degree as defined in the Scheme of Examinations of the concerned course.

The Department of Mathematics has opted option no. ii for the assessment of MSc (Mathematics) students.

(b) **Credit Based Grading System:-**

Key Definitions:

Programme: An educational programme leading to award of a Degree, diploma or certificate.

Course: Usually referred to, as 'papers' is a component of a programme. All courses need not carry the same weight

Credit: A unit by which the course work is measured. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours for Practical Work/Field Work/ Research Based Paper /Project per week.

Credit Point: Itis the product of grade point and number of credits for a course i,e, Credit Point = No. of credit in a course **x** "grade value" of the grade obtained in the course.

Semester Grade Point Average (SGPA): The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student andthe sum of the number of credits of all the Courses undergone by a student, i.e. SGPA(Si) =∑ (Cix Gi) /∑Ci

Cumulative Grade Point Average (CGPA):CGPA The is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of programme, i.e, CGPA =∑(Cix Si) / ∑Ci

Grade Point: Itis a numerical weight allotted to each letter grade on a l0-point scale with 7/6/5LETTER GRADES: **It** is an index of the performance of students in a said course.

Grades are denoted by letters 0, A+, A, B+, B, C, P and F etc.

Grade and its corresponding values. (For the courses where the pass marks are 50%)

[Faculty of Engineering & Technology, Law, Behavioural Sciences (Except B. Sc. (Clinical Psychology) & BA (Hons.) (Psychology), Fashion & Design, Mass Communication & Media Technology, Agricultural Sciences (Except M. Sc. programs), Education, Hotel & Tourism Management, Commerce & Management, Science, Allied Health Sciences, Physiotherapy]

Range of Percentage of Marks	Letter Grade	Grade Points	Range of Grade Points	Classification
90% and above	O (Outstanding)	10	9-10	Outstanding
80% and above but less than 90%	A+ (Excellent)	9	8<9	Excellent
70% and above but less than 80%	A (Very Good)	8	7<8	1st Division with Distinction
60% and above but less than 70%	B+ (Good)	7	6<7	1stDivision
Above 50% but less than	B (Above Average)	6	>5<6	2ndDivision

60%				
Minimum Pass Marks 50%	P (Pass Average)	5	5	Pass
Below minimum pass marks	F (Fail)	0	-	Fail

Grade and its corresponding values. (For the courses where the pass marks are 60%)

Faculty of Agricultural Sciences (M. Sc. programs)

Range of Percentage of Marks	Letter Grade	Grade Points	Range of Grade Points	Classification
90% and above	O (Outstanding)	10	9-10	Excellent
80% and above but less than 90%	A+ (Excellent)	9	8<9	1st Division with Distinction
70% and above but less than 80%	A (Very Good)	8	7<8	1st Division
Above 60% but less than 70%	B (Good)	7	>6<7	2nd Division
Minimum Pass Marks 60%	P (Pass)	6	6	Pass with 1st Division
Below minimum pass marks	F (Fail)	0	-	Fail

Grade and its corresponding values. (For the courses where the pass marks are 40%)

Faculty of Behavioural Sciences [B. Sc. (Clinical Psychology) & BA (Hons.) (Psychology)]

Range of Percentage of Marks	Letter Grade	Grade Points	Range of Grade Points	Classification
90% and above	O (Outstanding)	10	9-10	Outstanding
80% and above but less than 90%	A+ (Excellent)	9	8<9	Excellent
70% and above but less than 80%	A (Very Good)	8	7<8	1st Division with Distinction
60% and above but less than 70%	B+ (Good)	7	6<7	1st Division
50% and above but less than 60%	B (Above Average)	6	5<6	2nd Division
Above 40% but less than 50%	P (Pass Average)	5	>4<5	3rd Division
Minimum Pass Marks 40%	P (Pass Average)	4	4	Pass
Below minimum pass marks	F (Fail)	0	-	Fail

Semester Grade Point Average (SGPA):

SGPA (Si)=**Σ(Ci ×Gi)/ΣCi**

Where Ci is the number of credits of the ith course and Gi is the grade point scored as per marks obtained by the student in the ith course. Further, G is calculated as given below:

G=[Marks obtained in paper/Total marks of paper]×10 (The multiplication factor)

Cumulative Grade Point Average (CGPA):

CGPA=**Σ(Ci ×Si)/ΣCi**

Where Si is the SGPA of the ith Semester and Ci is the total number of credits in that Semester.

Formula for calculating percentage of marks;

CGPA×10 (The multiplication factor)

(c) **Grace Marks** :

Maximum 1% of total marks (Maximum to 5 marks) excluding internal assessment marks can be awarded to a student in one academic year.

13. Declaration of Results:

(a) After the semester/year examinations are over, the Controller of Examinations shall publish the results of those students who had appeared in the examinationspreferably within 45 days of last paper of course examination.

(b) Each successful student/ the student placed in reappear shall receive a copy of the Detailed Marks Certificate/ Grade Card Sheet of each semester examination.

(c) The successful students after the 4th, 6thor 8thsemester examination shall be equated in seven ascending letter grade (P to O) and grade points from 4 to 10 on the basis of final CGPA obtained by him/her in the 1st to 4th, 1st to6th or 1st to 8th semester examinations.

14. Discharge of the students from the program

The student who does not clear all the papers with in the stipulated time frame span period i.e. duration of the program + 02 years will be discharged from the programme.

15. Re-admission

As per the chapter 2, Clause 2.4.5. of the First Ordinance of the University, if a student remains absent, without leave of absence, from his/her classes for a continuous period of seven working days without any valid reason, medical or otherwise, his/her name shall be struck off from the rolls of the University. However, the student may be re-admitted on payment of the prescribed fee by the University from time to time, if Dean/Principal is satisfied that re-admission of the student will not fall short of requisite percentage of the attendance.

If a student is re-admitted, all his previous records are revived under the current structure, regulations and scheduled of fees.

A student, who has been rusticated or expelled from University, cannot be re-admitted.

16. Simultaneously pursuing other degree

As per the guidelines of the University Grants Commission, students will not be permitted to pursue two degrees simultaneously. If at any time, it comes to the notice of the University, his/her degree will be cancelled without any prior notice.

17. Appearing for additional papers after award of degree

The student will be allowed to appear for additional papers available in that degree course after the completion of course within the span period subject to attendance requirement and internal assessment. A separate marksheet will be issued for such paper(s).

18. Other Provisions:

(a) Nothing in this Ordinance shall debar the University from amending the Ordinance and the same shall be applicable to all the students from the date of its implementation.

(b) Any other provision not contained in the Ordinance shall be governed by the rules and regulations framed by the University from time to time.

(c) In case of any interpretation, The Vice-Chancellor is empowered in this regard and his interpretation shall be the final.

(d) This ordinance will be effective from the AdmissionsSession 2019-20.

Name of the Faculty : Faculty of Science

Name of the Program : M. Sc. (Mathematics) SESSION : 2019-20

										Theory		Practical/Dissertation					Internal						Oral				
Sr. No.	Semester/ Year	Course Code	Nomenclature	Theory/ Practical	Core/ AECC/ SEC/ DSE/ GE	Lecture	Tutorial	Practical	Credits	Max	Pass	Experimental Performance	Viva-voce	Lab Work / Dissertation Report	Max	Pass	Attendance	Midterm/ Internal Viva-Voice	Assignment	Project/Seminar	Max	Pass	Max	Pass	Overall Pass Marks	Whether to be offered under CBCS (Yes/No)	Scheme of Examinations (Theory +Internal+ Practical+Oral/ Theory+Internal +Practical/ Theory+Practical
1	I / I	17070101	Real Analysis	Theory	Core	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
2		17070102	Abstract Algebra	Theory	Core	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
3		17070103	Ordinary Differential Equation	Theory	Core	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
4		17070104	Ordinary Differential Equation Lab	Practical	Core			4	2			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
5		17070105	Probability & Mathematical Statistics	Theory	Core	4			4	60	24						5	20	5	10	40	16			50	NO	Theory+Internal
6		17070106	Probability & Mathematical Statistics Lab	Practical	Core			4	2			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
7		17070107	Professional Ethics and Human Values	Theory	SEC	2			2	30	12						5	10	5	0	20	8			20	NO	Theory+Internal
8		17070108	Basics of Matric Space	Theory	SEC	2			2	30	12						5	10	5	0	20	8			20	NO	Theory+Internal
9	II / I	17070201	Complex Analysis	Theory	Core	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
10		17070202	Measure Theory	Theory	Core	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
11		17070203	Partial Differential Equation	Theory	Core	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
12		17070204	Partial Differential Equation Lab	Practical	Core			4	2			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
13		17070205	Operational Research	Theory	Core	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
14		17070206	Operational Research Lab	Practical	Core			4	2			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
15		17070207	General Relativity & Cosmology	Theory	SEC	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
16		17070208	Fuzzy Sets and its Application	Theory	SEC	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
17	III / II	17070301	Linear Algebra	Theory	Core	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
18		17070302	Topology	Theory	Core	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
19		17070303	Statistical Inference	Theory	Core	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
20		17070304	Statistical Inference Lab	Practical	Core			4	2			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
21		17070305	Numerical Anslysis and application	Theory	Core	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
22		17070306	Numerical Anslysis and Application Lab	Practical	SEC			4	2			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
23		17070307	Differential Geometry	Theory	SEC	2			2	30	12						5	10	5	0	20	8			20	NO	Theory+Internal
24		17070308	Discrete Mathematics and Automata	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
25		17070309	Integral Equation and and Calculus of Variation	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
26	IV / II	17070401	Functional Analysis	Theory	Core	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
27		17070402	Number Theory	Theory	Core	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
28		17070403	Mathematical Programming and Application	Theory	Core	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
29		17070404	Project	Practical	Core			12	6				45	45	90	36	15	30		15	60	24			60	NO	Practical+Internal
30		17070405	Stochastic Process & its Application	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
31		17070406	Artificial Intelligence with Deep Learning	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
32		17070407	Graph Theory	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
33		17070408	Cryptography	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal

Department of Mathematics

M.Sc. (Mathematics)

Course Structure under Choice Based Credit System (CBCS): 2019-20

SEMESTER	COURSECODE	COURSENAME	L	T	P	Contact hours/ week	Credits	Max. Marks	Formative Assessment	Summative Assessment
I		**Core Courses (CC)**								
	17070101	Real Analysis	4	0	0	4	4	100	40	60
	17070102	Abstract Algebra	4	0	0	4	4	100	40	60
	17070103	Ordinary Differential Equation	4	0	0	4	4	100	40	60
	17070104	Ordinary Differential Equation Lab	0	0	4	4	2	50	20	30
	17070105	Probability & Mathematical Statistics	4	0	0	4	4	100	40	60
	17070106	Probability & Mathematical Statistics Lab	0	0	4	4	2	50	20	30
		Skill Enhancement Course (SEC)								
	17070107	Professional Ethics and Human Values	2	0	0	2	2	50	20	30
	17070108	Basics of Matric Space	2	0	0	2	2	50	20	30
Total Credits			**20**	**0**	**8**	**28**	**24**	**600**	**240**	**360**
II		**Core Courses(CC)**								
	17070201	Complex Analysis	4	0	0	4	4	100	40	60
	17070202	Measure Theory	4	0	0	4	4	100	40	60
	17070203	Partial Differential Equation	4	0	0	4	4	100	40	60
	17070204	Partial Differential Equation Lab	0	0	4	4	2	50	20	30
	17070205	Operational Research	4	0	0	4	4	100	40	60
	17070206	Operational Research Lab	0	0	4	4	2	50	20	30
	Skill Enhancement Course (SEC)(Choose any one of the following)									
	17070207	General Relativity & Cosmology	4	0	0	4	4	100	40	60
	17070208	Fuzzy Sets and its Application	4	0	0	4	4	100	40	60
Total Credits			**20**	**0**	**8**	**28**	**24**	**600**	**240**	**360**
III		**Core Courses(CC)**								
	17070301	Linear Algebra	4	0	0	4	4	100	40	60
	17070302	Topology	4	0	0	4	4	100	40	60
	17070303	Statistical Inference	4	0	0	4	4	100	40	60
	17070304	Statistical Inference Lab	0	0	4	4	2	50	20	30

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	17070305	Numerical Analysis and application	4	0	0	4	4	100	40	60
	17070306	Numerical Analysis and Application Lab	0	0	4	4	2	50	20	30
	Skill Enhancement Course (SEC)									
	17070307	Differential Geometry	2	0	0	2	2	50	20	30
	Discipline Elective Courses (Choose any one of the following)									
	17070308	Discrete Mathematics and Automata	4	0	0	4	4	100	40	60
	17070309	Integral Equation and and Calculus of Variation	4	0	0	4	4	100	40	60
Total Credits			**22**	**0**	**8**	**30**	**26**	**650**	**260**	**390**
IV		**Core Courses(CC)**								
	17070401	Functional Analysis	4	0	0	4	4	100	40	60
	17070402	Number Theory	4	0	0	4	4	100	40	60
	17070403	Mathematical Programming and Application	4	0	0	4	4	100	40	60
	17070404	Project	0	0	12	12	6	150	60	90
	Discipline Specific Elective Courses (Choose any two of the following)									
	17070405	Stochastic Process & its Application	4	0	0	4	4	100	40	60
	17070406	Artificial Intelligence with Deep Learning	4	0	0	4	4	100	40	60
	17070407	Graph Theory	4	0	0	4	4	100	40	60
	17070408	Cryptography	4	0	0	4	4	100	40	60
Total Credits			**20**	**0**	**12**	**32**	**26**	**650**	**260**	**390**
Grand Total			**82**	**0**	**36**	**118**	**100**	**2500**	**1000**	**1500**

Scheme of Studies M.Sc. (Mathematics): 2019-20

Category	Credits	%
Core Course	78	78
Discipline Specific Elective Course (DSE)	12	12
Skill Enhancement Course (SEC)	10	10
Total Credits	100	100

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Syllabus M.Sc. (Mathematics) 2019-2020

Semester - I

Core Courses:

1. Real Analysis
2. Abstract Algebra
3. Ordinary Differential Equation
4. Ordinary Differential Equation Lab
5. Probability and Mathematical Statistics
6. Probability and Mathematical Statistics Lab

Skill Enhancement Course

1. Professional Ethics and Human Values
2. Basics of Matric Space

Semester – II

Core Courses:

1. Complex Analysis
2. Measure Theory
3. Partial Differential Equation
4. Partial Differential Equation Lab
5. Operational Research
6. Operational Research Lab

Skill Enhancement Course (Choose any one of the following)

1. General Relativity and Cosmology
2. Fuzzy Sets and its Application

Semester – III

Core Courses:

1. Linear Algebra
2. Topology
3. Statistical Inference
4. Statistical Inference Lab
5. Numerical Analysis and Application
6. Numerical Analysis and Application Lab

Skill Enhancement Course (SEC)

Differential Geometry

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Discipline Specific Elective Courses (Choose any one of the following)

1. Discrete Mathematics and Automata
2. Integral Equation and Calculus of Variation

Semester – IV

Core Courses:

1. Functional Analysis
2. Number Theory
3. Mathematical Programming and Application
4. Project

Discipline Specific Elective Courses (Choose any two of the following)

1. Stochastic Process & its Applications
2. Artificial Intelligence with Deep Learning
3. Graph Theory
4. Cryptography

1. Name of the Departm nt: Mathematics						
2. Course Name	Re l Analysis	**L**	**T**		**P**	
3. Course Code	17 70101	4	0		0	
4. Type of Course (use ti k mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem()
7. Total Number of Lect res, Tutorials, Practical						
Lectures = 50		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

This course covers some fu damental topics of mathematical analysis. In this course the students will be taught Riemann Stieltjes tegral, uniform convergence of sequences and series of functions, and functions of several variable

9. Course Objectives:

The objective of this cour is to introduce some fundamental topics of mathematical analysis like Riemann Stieltjes integral, niform convergence of sequences and series of functions, and functions of several variables which are rectly relevant in some other papers of M.Sc. Mathematics course also.

10. Course Outcomes (CO):

1. Students in this course ill demonstrate ability to work with Riemann Stieltjes integral.
2. Students in this course ill be able to solve problems based on function of several variables.
3. Students in this course ill come to know about sequence and series of functions and their convergence.
4. in this course will come to know about some basic concepts of mathematical analysis like power series, Fourier series, ga mma functions etc.

11. Unit wise detailed cont nt

Unit-1	**Number of l ctures = 10**	**Title of the unit: Riemann Stieltjes Integral**

Definition and existence of Riemann Stieltjes integral, properties of the integral, reduction of Riemann Stieltjes integral to ordinary Riemann integral, change of variable, integration and differentiation, the fundamental theorem of inte gral calculus, integration by parts, first and second mean value theorems for Riemann Stieltjes integrals, i ntegration of vector-valued functions.

Unit – 2	**Number of lectures = 15**	**Title of the unit: Sequences and Series of Functions**

Point wise and uniform convergence of sequences of functions, Cauchy criterion for uniform convergence, Uniform convergence and continuity, uniform convergence and Riemann integration, uniform convergence and differentiation, convergence and uniform convergence of series of functions, Weierstrass M-test, Ables test, integration and differentiation of series of functions, existence of a continuous nowhere differentiable function, the Weierstrass approximation theorem.

Unit – 3	**Number of lectures = 15**	**Title of the unit: Functions of several variables**

Functions of several variables : Linear transformations, the space of linear transformations on R_n to R_m as a metric space, open sets, continuity, derivative in an open subset of R_n, chain rule, partial derivatives, directional derivatives, continuously differentiable mappings, necessary and sufficient conditions for a mapping to be continuously differentiable, contractions, the contraction principle (fixed point theorem), the inverse function theorem, the implicit function theorem.

Unit – 4	**Number of lectures = 10**	**Title of the unit: Power Series**

Power Series : Uniqueness theorem for power series, Abel's and Tauber's theorem, Taylor's theorem,

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Exponential & Logarithmic functions, trigonometric functions, Fourier series, Gamma function.
12. Brief Description of self learning / E-learning component
https://youtu.be/LUKfrjpDHTk https://youtu.be/2iXpgCdQDuM https://youtu.be/ZZUYzTsBk-0
13. Books Recommended
1. Principles of Mathematical Analysis' by Walter Rudin (3rd Edition) McGraw-Hill, 1976 2. T.M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985. 3. S.C. Malik and SavitaArora, Mathematical Analysis, New Age International Limited, New Delhi,4th Edition 2010. 4. D. Somasundaram and B. Choudhary : A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi, 1997. 5. Gabriel Klambauer, Mathematical Analysis, Marcel Dekkar, Inc. New York, 1975.

1. Name of the Department: Mathematics						
2. Course Name	Abstract Algebra	**L**	**T**		**P**	
3. Course Code	17070102	4	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 50	**Tutorials = 0**	**Practical = 0**

8. Course Description:

This Course covers properties of integer sets, group, permutation group homomorphism and isomorphism of groups .In this course also discuss the nilpotent group ,field theory , finite field

9. Course Objectives:

This course aims provide a approach to the subject of Algebra, which is one of the basic pillar of modern Mathematics. This course gives to a student a good mathematical maturity and enables to build mathematical thinking and skill.

10. Course Outcomes (COs):

The Students should be able to solve their problem of nilpotent group, field theory and finite field. The students will demonstrate understanding of the importance of algebraic properties. They should use their skills of abstract algebra to solving different types of problems

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Groups& Normal subgroups**

Groups, symmetric groups, Cayleys theorem, Normal subgroups, center of a group, quotient groups, Fundamental theorem on homomorphisms, Class equation of groups, Cauchys Theorems for abelian and non abelian groups, Sylow's Theorems for abelian and non abelian groups.

Unit – 2	**Number of lectures = 15**	**Solvable Group**

Maximal groups, composition Series of a group, Jordan Holder Theorem, solvable groups, nilpotent groups, direct product of groups, structure theorem for finite abelian groups.

Unit – 3	**Number of lectures = 10**	**Ring Theory**

Rings, homomorphism of rings, ideals, maximal ideals, quotient rings, Integral Domains, Fields, Euclidean domains, PID, UFD, Polynomial rings, polynomial over the rational fields, Gauss lemma, Eisenstein criterion.

Unit – 4	**Number of lectures = 10**	**Modules**

Modules, Definition and examples, Direct sum, Free modules, Quotient modules, Simple modules, Modules over Principle ideal domains, Modules with chain conditions, Artenian Modules, Noetherian Modules, Hilberts basis theorem.

12. Brief Description of self-learning / E-learning component

https://www.youtube.com/watch?v=g7L_r6zw4-c

https://www.youtube.com/watch?v=GJtNLiG4Hv8

https://www.youtube.com/watch?v=DSxOCdpmeBI

13. Books Recommended

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1. I.N.Herstein, I.N. Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul. Basic Abstract Algebra. 2nd ed. Cambridge University Press, Indian Edition, 1997.
3. P.M. Cohn. Algebra. Vols. I, II & III. John Wiley, 1991.
4. N. Jacobson. Basic Algebra. Vol. I &II.Hindustan Publishing Company.
5. S. Lang. Algebra. 3rd ed. Addison-Wesley, 1993.
6. I.S. Luther and I.B.S.Passi. Algebra. Vol. I – II. NarosaPublishing House, 1990; 1996.
7. D.S. Malik, J.N. Mordenson, and M.K. Sen. Fundamentals of Abstract Algebra. International ed. McGraw-Hill, 1997.
8. VivekSahaiandVikasBist. Algebra. Narosa Publishing House , 1999

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1. Name of the Department: Mathematics						
2. Course Name	Ordinary Differential Equations (ODEs)	**L**	**T**		**P**	
3. Course Code	17070103	4	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 50		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

Linear differential equations of nth order, fundamental sets of solutions, Wronskian, adjoint – self - adjoint linear operator, Green's formula, Adjoint equations, the nth order non-homogeneous linear equations- Variation of parameters, Fundamental existence and uniqueness theorem, Sturm-Liouville problems- Orthogonality of eigenfunctions, Power series solution of linear differential equations, matrix method, Linear and Non-linear autonomous system of equations - Phase plane - Critical points – stability.

9. Course Objectives:

The general purpose of this course is to provide an understanding of basic and advanced methods for solving differential equations.

10. Course Outcomes (COs):

Differential equations play an important role in modelling virtually every physical, technical, or biological process, from celestial motion, to bridge design, to interactions between neurons. This course provides an introduction to methods for solving and analysing ordinary differential equations.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Linear differential equations: Basic**

Linear differential equations of nth order, fundamental sets of solutions, Wronskian –Abel's identity, theorems on linear dependence of solutions, adjoint – self - adjoint linear operator, Green's formula, Adjoint equations, the nth order non-homogeneous linear equations- Variation of parameters - zeros of solutions – comparison and separation theorems.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Existence- Uniqueness of solutions for ODEs**

Fundamental existence and uniqueness theorem. Dependence of solutions on initial conditions, existence and uniqueness theorem for higher order and system of differential equations – Eigenvalue problems – Sturm-Liouville problems- Orthogonality of eigenfunctions - Eigenfunction expansion in a series of orthonormal functions- Green's function method.

Unit – 3	**Number of lectures = 15**	**Title of the unit: Series Solution of ODEs**

Power series solution of linear differential equations- ordinary and singular points of differential equations, Classification into regular and irregular singular points; Series solution about an ordinary point and a regular singular point – Frobenius method- Hermite, Laguerre, Chebyshev and Gauss Hypergeometric equations and their general solutions. Generating function, Recurrence relations, Rodrigue's formula-Orthogonality properties. Behaviour of solution at irregular singular points and the point at infinity.

Unit – 4	**Number of lectures = 10**	**Title of the unit: Matrix Method for ODEs & Stability Analysis**

Linear system of homogeneous and non-homogeneous equations (matrix method) Linear and Non-linear autonomous system of equations - Phase plane - Critical points – stability - Liapunov direct method

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12. Brief Description of self learning / E-learning component
http://nptel.ac.in/courses/111108081/ https://ocw.mit.edu/courses/mathematics/18-03-differential-equations-spring-2010/video-lectures/
13. Books Recommended
1. G.F. Simmons: Differential Equations, TMH Edition, New Delhi, 1974. 2. M.S.P. Eastham: Theory of ordinary differential equations, Van Nostrand, London, 1970. 3. S.L. Ross: Differential equations (3rd edition), John Wiley & Sons, NewYork, 1984. 4. E.D. Rainville and P.E. Bedient: Elementary Differential Equations, McGraw Hill, NewYork, 1969. 5. E.A. Coddington and N. Levinson: Theory of ordinary differential equations, McGraw Hill, 1955. 6. A.C. King, J. Billingham and S.R. Otto: 'Differential equations', Cambridge University Press, 2006.

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1. Name of the Department: Mathematics						
2. Course Name	Ordinary Differential Equations Lab	**L**	**T**		**P**	
3. Course Code	17070104	0	0		4	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 35**		

8. Course Description:

This course is designed to emphasize the knowledge of differential equations. Emphasis is placed on different forms of linear and non-linear differential equations. Upon completion, students should be able to write the programs in Matlab or other software's.

9. Course Objectives:

- give an account of basic concepts and definitions for differential equations;
- use methods for obtaining exact solutions of linear homogeneous and non-homogeneous differential equations;
- describe some simple numerical solution techniques and be familiar with mathematical software for differential equations;
- use elementary methods for linear systems of differential equations.
-

10. Course Outcomes (COs):

After completing the course, students are expected to be able to solve differential equations analytically.

List of Practical's (using any one from C,C++ , MATLAB, Maple)

- To solve differential equation by basic methods with and without initial conditions.
- To solve first order Bernoulli equations
- To solve Non-linear differential equations with initial conditions
- To solve second order ODE with initial conditions
- To solve nth order non-homogeneous linear equations
- To solve Eigenvalue problems
- To solve Sturm-Liouville problems
- To Solve Hermite, Laguerre, Chebyshev and Gauss Hypergeometric equations

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- To find Power series solution of linear differential equations
- Solution by Euler's and modified Euler's methods of ODEs
- R.K method to solve system of ODEs.

11. Books Recommended

1. Gurpreet Singh Tuteja, "Practical Mathematics, International BOOK house Pvt Ltd.
2. https://www.mathworks.com/help/symbolic/solve-a-single-differential-equation.html
3. https://in.mathworks.com/help/symbolic/solve-a-system-of-differential-equations.html
4. https://www.mathworks.com/help/matlab/math/choose-an-ode-solver.html
5. http://www.math.tamu.edu/undergraduate/research/REU/comp/matode.pdf

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1. Name of the Department: Mathematics						
2. Course Name	Probability & Mathematical Statistics	**L**	**T**		**P**	
3. Course Code	17070105	4	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 50	**Tutorials = 0**	**Practical = 0**

8. Course Description:

This course introduces fundamental concepts, theories and primitive applications of probability and mathematics statistics. This course develops the building blocks of probability theory that are necessary to understand statistical inference. In this course the concept of probability and their axioms are reviewed, discrete and continuous random variables are introduced, and their properties are developed in the univariate and bivariate setting.In particular, we discuss the most common probability distributions that arise in statistical applications.

Topic includes: Concept of Probability, Bayes theorem and its applications, Random variables, Mathematical expectation, Moment generating function, Chebyshev's inequality, law of large numbers, central limit theorem and some common probability distributions that arise in statistical applications etc.

9. Course Objectives:

1. To provide students with a good understanding of the theory of probability, both discrete and continuous, including variety of useful distributions, expectation and variance, analysis of sample statistics, and central limit theorems.
2. To help students develop the ability to solve problems using probability.
3. To introduce students to some of the basic methods of statistics and prepare them for further study in statistics.

10. Course Outcomes (COs):

This course intends to help students with major in science, engineering, and other related fields to develop their computing skills of probability and mathematical statistics and advanced ability to solve practical problems with mathematics. On successful completion of this course students will be able to:

1. demonstrate knowledge of, and properties of, statistical models in common use,
2. understand the basic principles underlying statistical inference (estimation and hypothesis testing).

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Probability**

Probability: Definition and various approaches of probability, Addition theorem, Boole inequality, Conditional probability and multiplication theorem, Independent events, Mutual and pairwise independence of events, Bayes theorem and its applications.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Random variables and their function**

Random variable and probability functions: Definition and properties of random variables, Discrete and continuous random variables, Probability mass and density functions, Distribution function. Mathematical

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expectation: Definition and its properties. Variance, Covariance, Moment generating function- Definitions and their properties. Chebyshev's inequality, law of large numbers, central limit theorem.		
Unit - 3	**Number of lectures = 15**	**Title of the unit: Probability distributions**
Discrete distributions: Uniform, Bernoulli, Binomial, Poisson and Geometric distributions with their properties. Continuous distributions: Uniform, Exponential, Gamma, Beta and Normal distributions with their properties.		
Unit - 4	**Number of lectures = 15**	**Title of the unit: Sampling distribution and Test Statistics**
Population, sample, parameter and statistics, Simple random sampling with replacement and without replacement, sampling distribution of statistic, standard error, Fundamental sampling distribution from normal population viz. Chi-square distribution, Student's t distribution, Snedecor's F-distribution, Fisher's - Z distribution.		
12. Brief Description of self learning / E-learning component		
http://nptel.ac.in/courses/111105041/1 https://www.youtube.com/watch?v=r1sLCDA-kNY https://www.youtube.com/watch?v=9EqUH9wsM6c		
13. Books Recommended		
1. R.V. Hogg and T. Craig, Introduction to Mathematical Statistics , 7th addition, Pearson Education Limited-2014 2. Zhou Sheng, ShiqianXie, Chengyi Pan, Probability and Mathematics Statistics, 4th Edition, Higher Education Press, 2011 3. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, S. Chand Pub., New Delhi, 2014 4. Rick Durrett, Probability: Theory and Examples, Cambridge University Press, 2010 5. Jun Shao, Mathematical Statistics, Springer-Verlag, 2010		

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1. Name of the Department: Mathematics						
2. Course Name	Probability & Mathematical Statistics Lab	**L**	**T**		**P**	
3. Course Code	17070106	0	0		4	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**	**Practical =35**			

8. Course Description:

This course introduces fundamental concepts, theories and primitive applications of probability and mathematics statistics. This course develops the building blocks of probability theory that are necessary to understand statistical inference. In this course the concept of probability and their axioms are reviewed, discrete and continuous random variables are introduced, and their properties are developed in the univariate and bivariate setting.In particular, we discuss the most common probability distributions that arise in statistical applications.

Topic includes: Concept of Probability, Bayes theorem and its applications, Random variables, Mathematical expectation, Moment generating function, Chebyshev's inequality, law of large numbers, central limit theorem and some common probability distributions that arise in statistical applications etc.

9. Course Objectives:

4. To provide students with a good understanding of the theory of probability, both discrete and continuous, including variety of useful distributions, expectation and variance, analysis of sample statistics, and central limit theorems.
5. To help students develop the ability to solve problems using probability.
6. To introduce students to some of the basic methods of statistics and prepare them for further study in statistics.

10. Course Outcomes (COs):

This course intends to help students with major in science, engineering, and other related fields to develop their computing skills of probability and mathematical statistics and advanced ability to solve practical problems with mathematics. On successful completion of this course students will be able to:

3. demonstrate knowledge of, and properties of, statistical models in common use,
4. understand the basic principles underlying statistical inference (estimation and hypothesis testing).

11. Probability & Mathematical Statistics Lab Syllabus:

Practical Based on Syllabus: Programming in "C" or Applying software packages for problems based on Theory paper Probability & Mathematical Statistics (08030105).

Use of Statistical Software packages such as MINITAB, SPSS, Statgraf etc.

Practical Exercises for Statistical techniques based on topics in paper Probability & Mathematical Statistics (08030105).

Note:

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1. At least eight experiments are to be performed in the semester.

2. At least three experiments are based on Software and remaining experiments are based on conventional methods.

3. At least six experiments should be performed from the above list. Remaining two experiments may either be performed from the above list or designed & set by the department as per the scope of the syllabus.

12. Brief Description of self learning / E-learning component

http://nptel.ac.in/courses/111105041/1

https://www.youtube.com/watch?v=r1sLCDA-kNY

https://www.youtube.com/watch?v=9EqUH9wsM6c

13. Books Recommended

6. R.V. Hogg and T. Craig, Introduction to Mathematical Statistics , 7th addition, Pearson Education Limited-2014
7. Zhou Sheng, ShiqianXie, Chengyi Pan, Probability and Mathematics Statistics, 4th Edition, Higher Education Press, 2011
8. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, S. Chand Pub., New Delhi, 2014
9. Rick Durrett, Probability: Theory and Examples, Cambridge University Press, 2010
10. Jun Shao, Mathematical Statistics, Springer-Verlag, 2010

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1. Name of the Department :Chemistry						
2. Course Name	Professional ethics and human value	**L**		**T**	**P**	
3. Course Code	17070107	2		0	0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 26		**Tutorials = 0**		**Practical = 0**		

8. Course Description:

This course provides students with the knowledge of ethics in professional life. Some of the examples from history and day to day life will make the students more responsible towards their profession, society and family .

9. Course Objectives:

1. To develop ethical and human values in students
2. To developthe responsibility in students at professional and societal levels.

10. Course Outcomes (COs):

1. The students will understandthe values of professional ethics and moral values deeply.
2. The students will be able to take strong decisions and perform their duties responsibly as on professional.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Ethics and Human Values**

Definition, History and Development of Ethics, Universal declaration on Bioethics, ,Theories related to Bioethics: Utilitarian theory, Deontological theory and Communication theory.
Human Rights and Values : Autonomy, Consent, Equality, Confidentiality, Vulnerability and Personal Integrity
Environmental Ethics, Animal ethics

Unit –2	**Number of lectures = 14**	**Title of the unit: Professional Ethics & Responsibility**

Need and Importance of professional ethics, Goals, Dignity of Labour,IRB &its functions, Authorship

Religious and Cultural Values, Importance of a Family, Guidance to youngsters, Gender Equality

Responsibilities towards Safety and Risk, Voluntary v/sIn voluntary Risk, Designing/Research for Safety – Risk, Benefit Analysis, Accidents.Disaster ethics,

Ethics in Media and Technology, Research Ethics, Intellectual Property Rights.

12. Brief Description of self learning / E-learning component

1. https://www.youtube.com/watch?v=cFOZplkRqsk&authuser=2
2. https://www.youtube.com/watch?v=HJk1Eodmf9A&authuser=2
3. https://www.youtube.com/watch?v=Fqt7m8LH5GY&authuser=2

4. https://youtu.be/2VYF_t51FyE
5. https://youtu.be/hjzA_rZG-bU

13. Books Recommended

1. Professional Ethics and Morals by Prof.A.R.Aryasri, DharanikotaSuyodhana – Maruthi Publications.
2. Professional Ethics and Human Values by A. Alavudeen, R.KalilRahman and M. Jayakumaran – University Science Press.
3. Professional Ethics and Human Values by Prof.D.R.Kiran-Tata McGraw-Hill – 2013

1. Name of the Department: Mathematics						
2. Course Name	Basics of Metric Space	**L**	**T**		**P**	
3. Course Code	17070108	2	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 30	**Tutorials = 0**	**Practical = 0**

8. Course Description:

The course unit aims to introduce the basic ideas of metric spaces. This course is designed as a basic introductory course in the analysis of metric.

9. Course Objectives:

The aim of the course is to provide for the students an introduction to theory of metric spaces with emphasis on those topics that are important to higher mathematics. The course focuses on the basic notions of metric spaces, properties of continuous mappings selected types of metric spaces (compact and connected spaces) and basic theorems on metric spaces.

10. Course Outcomes (COs):

On successful completion of this course, students will be able toidentify the three properties of a metric or distance; define the basic terms and concepts in metric space, classify and explain open and closed sets, adherent points, convergent and Cauchy convergent sequences, complete spaces, compactness and connectedness etc., and prove logically theorems in metric space using the definitions of basic terms and properties of metric spaces.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit: Basics of Metric Space**

Metric on a set, pseudo-metrics and metrics Distance between two sets. Equivalent metrics, Limit points and closure: closed sets, Derived set of a set. Adherent points and closure of a set, Dense-subsets, Interior of a set and its properties, Subspaces, Product spaces, Structure of Open balls in a product space. Closures and interiors in a product space, Finite product of metric spaces.

Unit – 2	**Number of lectures = 15**	**Title of the unit: Continuous Functions**

Convergent sequences. Cauchy sequences, adherent points and limit points in terms of convergent sequences, Continuity at a point, Continuity over a space, Continuity of composite, graph and projection maps, Algebra of real valued continuous functions in a metric space. Homeomorphisms, Isometries, relation between isometries and Homeomorphism, Uniform continuity.

12. Brief Description of self learning / E-learning component

http://www.maths.manchester.ac.uk/~cwalkden/ergodic-theory/metric_spaces.pdf

http://www.math.northwestern.edu/~scanez/courses/320/notes/metric-spaces.pdf

http://alpha.math.uga.edu/~usher/notes.pdf

http://www.newagepublishers.com/samplechapter/001589.pdf

13. Books Recommended

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1. G. F Simmons: Introduction to Topology and Modern Analysis, McGraw Hill, India
2. E.T Copson: Metric Spaces, Cambridge
3. Dieudonne: Foundation of Modern Analysis, Academic Press, NY
4. Kasriel: Metric Spaces, Wiley, NY

1. Name of the Department: Mathematics						
2. Course Name	Complex Analysis	**L**	**T**		**P**	
3. Course Code	17070201	4	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 50	**Tutorials = 0**	**Practical =0**

8. Course Description:

The subject gives an introduction to the theory of functions of complex variable. Discuss in the course are analytic and harmonic functions and their properties, power series and Laurent series, isolated singularities, Cauchy's integral theorem and residue calculus.

9. Course Objectives:

Students will be equipped with the understanding of the fundamental concepts of complex Analysis. In particular, students will acquire the skill of contour integration to evaluate complicated real integrals via residue calculus.

10. Course Outcomes (COs):

After studied the course will be able to analyses complex exponential, logarithm and Calculate the image of circles and lines. Find harmonic function, Express analytic functions in terms of power series and Laurent series. Calculate complex line integrals and some infinite real integrals using Cauchy's integral theorem or residue calculus.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit: Function of Complex Variable**

Analytic functions and their properties, Cauchy-Riemann equations in Cartesian and polar coordinates. Power series, Radius of convergence, Differentiability of sum function of a power series, Branches of many valued functions with special reference to arg z, log z and z^a , Complex integration, Cauchy theorem, Cauchy's integral formula, Poisson's integral formula , Higher order derivatives, Complex integral as a function of its upper limit, Morera's theorem ,Cauchy's inequality, Liouville's theorem, The fundamental theorem of algebra., Taylor's theorem.

Unit – 2	**Number of lectures = 15**	**Title of the unit: Zeros of Analytic Functions**

Zeros of an analytic function, Laurent's series, Isolated singularities, Casporati-Weierstress theorem, Limit point of zeros and poles, Maximum modulus principle, Minimum modulus principle, Schwarz lemma, Meromorphic functions, The argument principle, Rouche's theorem, Inverse function theorem.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Calculus of Residue**

Calculus of residues, Cauchy's residue theorem, Evaluation of integrals, Bilinear transformations, their properties and classifications, Definitions and examples of Conformal mappings, Space of analytic functions and their completeness, Hurwitz's theorem, Montel's theorem, Riemann mapping theorem.

Unit – 4	**Number of lectures = 10**	**Title of the unit: Integral Functions.**

Integral Functions, Factorization of an integral function, Weierstrass' factorisation theorem, Factorization of sine function, Gamma function and its properties, Stirling formula, Integral version of gamma function,

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Riemann Zeta function, Riemann' functional equation, Schwarz Reflection principle.
12. Brief Description of self learning / E-learning component
www.youtube.com/watch?v=yV_v6zxADgY&index=10&list=PLbMVogVj5nJS_i8vfVWJG16mPcoEKMuWT https://nptel.ac.in/courses/111107056/ https://nptel.ac.in/courses/111103070/
13. Books Recommended
1. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford, 1990. 2. J.B. Conway, Functions of one Complex variable, Springer-Verlag, International student-Edition, Narosa Publishing House, 1980. 3. Liang-shin Hann&Bernand Epstein, Classical Complex Analysis, Jones and Bartlett Publishers International, London, 1996. 4. E.T. Copson, An Introduction to the Theory of Functions of a Complex Variable, Oxford University Press, London. 5. E.C. Titchmarsh, The Theory of Functions, Oxford University Press, London. 6. L.V. Ahlfors, Complex Analysis, McGraw Hill, 1979.

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1. Name of the Department: Mathematics						
2. Course Name	Measure Theory	**L**	**T**		**P**	
3. Course Code	17070202	4	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 50	**Tutorials = 0**	**Practical = 0**

8. Course Description:

Measure theory and theory of the integral developed by Lebesgue at the beginning of the last century found numerous applications in other branches of pure and applied mathematics, for example in the theory of (partial) differential equations, functional analysis and fractal geometry; it is used to give mathematical foundation to probability theory and statistics, and on the real line it gives a natural extension of the Riemann integral which allows for better understanding of the fundamental relations between differentiation and integration. This course provides the essential foundations of this important aspect of mathematical analysis.

9. Course Objectives:

Students will be able to understand :

1. Studying the theory of Lebesgue measure through the abstract theory of Lebesgue-Stieltjes measures.
2. Studying the differences between the Riemann integral and the Lebesgue integral as a basis for further study of function spaces.

10. Course Outcomes (COs):

By the end of this course, students should be able to

1. Minimal: Essential understanding of the concepts of measure and Lebesgue integral.
2. Expected: Additionally, students should master the technique of calculating the Lebesgue integral and understand the applications of Lp-spaces in probability theory

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Measurable Functions**

Measures, some properties of measures, outer measures, extension of measures, uniqueness of extension, completion of a measure, the LUB of an increasingly directed family of measures .Measurable functions, combinations of measurable functions, limits of measurable functions, localization of measurability, simple functions.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Measure Spaces**

Measure spaces, almost everywhere convergence, fundamental almost everywhere, convergence in measure, fundamental in measure, almost uniform convergence, Egoroff's theorem, Riesz-Weyltheorem. Integration with respect to a measure: Integrable simple functions, non-negative integrable functions, integrable functions, indefinite integrals, the monotone convergence theorem, mean convergence.

Unit – 3	**Number of lectures = 15**	**Title of the unit: Product and signed measures**

Product Measures: Rectangles, Cartesian product of two measurable spaces, measurable rectangle, sections, the product of two finite measure spaces, the product of any two measure spaces, product of two σ - finite measure spaces; iterated integrals, Fubini's theorem, a partial converse to the Fubini's theorem,

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Signed Measures: Absolute continuity, finite singed measure, contractions of a finite signed measure, purely positive and purely negative sets, comparison of finite measures, Lebesgue decomposition theorem, a preliminary Radon-Nikodym theorem, Hahn decomposition, Jordan decomposition, upper variation, lower variation, total variation, domination of finite signed measures, the Radyon-Nikodym theorem for a finite measure space, the Radon-Nikodym theorem for a σ - finite measure space

Unit – 4	Number of lectures = 15	Title of the unit: Measurable Integration

Integration over locally compact spaces: continuous functions with compact support, Gδ 's and Fσ's, Baire sets, Baire function, Baire-sandwich theorem, Baire measure, Borel sets, Regularity of Baire measures, Regular Borel measures, Integration of continuous functions with compact support, Riesz-Markoff's theorem.

12. Brief Description of self learning / E-learning component

Learners are offered e-learning courseware (also called Web-based training (WBT)), which can be complemented by supplemental resources and assessments.

Courseware is usually housed on a Web server, and learners can access it from an online learning platform or on CD-ROM

http://www.nptelvideos.com/course.php?id=731

https://swayam.gov.in/course/3790-measure-theory

13. Books Recommended

1. H.L.Royden: Real Analysis, Prentice Hall of India, 3rd Edition, 1988.
2. G.de Barra: Measure Theory and Integration, Wiley Eastern Ltd.,1981.
3. P.R.Halmos: Measure Theory, Van Nostrand, Princeton, 1950.
4. I.K.Rana: An Introduction to Measure and Integration, Narosa Publishing House, Delhi, 1997.
5. R.G.Bartle: The Elements of Integration, John Wiley and Sons, Inc. New York, 196

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1. Name of the Department: Mathematics						
2. Course Name	Partial differential Equations	**L**	**T**		**P**	
3. Course Code	17070203	4	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 50		**Tutorials = 0**		**Practical = 0**		

8. Course Description:

Linear and semi-linear equations, Cauchy problem, Method of characteristics. Nonlinear first order PDE's: Complete integrals, Envelopes and singular solutions. Cauchy-Kowalewsky theorem, Classification of second order equations, wave equation in one space dimension, classical and weak solutions, Duhamel's principle. Laplace equation, fundamental solutions, maximum principles and mean value formulas, Properties of harmonic functions, Green's function, Energy methods, Perron's method, Parabolic equations in one space dimension, fundamental solution, maximum principle, existence and uniqueness theorems.

9. Course Objectives:

To use students knowledge in Multivariable calculus in solving Partial differential equations and also to give a concise account of fundamental concepts of existence, uniqueness and qualitative properties of strong and weak solutions.

10. Course Outcomes (COs):

On successful completion of this course, students will be able to

Many physical processes such as vibrating strings, diffusion of heat and fluid flows are well modelled by partial differential equations. This course provides an introduction to methods for solving and analysing standard partial differential equations.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**First order partial differential equations**

Linear and semi-linear equations, Cauchy problem, Method of characteristics. Nonlinear first order PDE's: Complete integrals, Envelopes and singular solutions, Lagrange and Charpit methods for solving first order PDE's.

Unit – 2	**Number of lectures = 10**	**Classical and weak solutions**

Cauchy-Kowalewsky theorem (statement only), Holmgren's Uniqueness Theorem, Method of separation of variables for Wave equation, Wave equation in one space dimension, classical and weak solutions.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Second order Elliptic (Laplace) equation**

Classification of second order equations, Method of separation of variables Laplace equation, fundamental solutions, maximum principles and mean value formulas, Properties of harmonic functions, Green's function, Energy methods, Perron's method.

Unit – 4	**Number of lectures = 20**	**Title of the unit: Parabolic equation, Second order wave equation, Higher order PDE's**

Parabolic equations in one space dimension, fundamental solution, maximum principle, existence and uniqueness theorems, Solutions by spherical means, Non Homogeneous Problems, Duhamel's principle,

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Energy Methods. Method of separation of variables for Heat equations, General solutions of higher order PDE's with constant coefficients.
12. Brief Description of self learning / E-learning component
1. http://nptel.ac.in/courses/111103021/39 2. http://freevideolectures.com/Course/3294/Partial-differential-equations 3. https://math.stackexchange.com/questions/2508796/finding-the-complete-integral-of-a-non-linear-pde-of-the-first-order
13. Books Recommended
1. L. C. Evans, Partial Differential Equations, AMS, 1998. 2. R. McOwen, Partial Diffrential Equations, Pearson, 2002. 3. I. N. Sneddon, Elements of Partial Differential Equations, McGraw Hill, 1957. 4. F. John, Partial Differential Equations, Springer Verlag, 1982. 5. W.A. Strauss, Partial Differential Equations: An Introduction, John Wiley, 1992. 6. W. E. Willams, Partial Differential Equations, Oxford, 1980. 7. T. Amarnath, An Elementary Course in Partial Differential Equations, Narosa Publishing House.

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1.Name of the Department: Mathematics						
2.Course Name	Partial differential Equations Lab	**L**	**T**		**P**	
3.Course Code	17070204	0	0		4	
4.Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5.Pre-requisite (if any)		**6.Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7.Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 35**		

8.Course Description:

Linear and semi-linear equations, Cauchy problem, Method of characteristics. Nonlinear first order wave equation in one space dimension, Duhamel's principle. Laplace equation, fundamental solutions, maximum principles and mean value formulas, , Green's function, Energy methods, Parabolic equations in one space dimension, fundamental solution, maximum principle.

9.Course Objectives:

The objective of this course is to introduce Post graduate students to computational methods using MATLAB, PYTHON, MATHEMATICA, SCILAB, MAPLE etc.

At the end of this course, a student would: Learn basics of these softwares programming Get introduced to Partial Differential Equations.

10.Course Outcomes (COs):

On successful completion of this course, students will be able to

Solve elliptic, parabolic, hyperbolic , Laplace, wave, Heat equations using the software Matlab, Python, Mathematica, Scilab, Maple.

Write simple programs in any one software to solve scientific and mathematical problems like Partial differential equations.

11.Partial Differential Equation Lab – Do at least 10 experiments from the following

1. Finite Difference Methods for Solving Elliptic Partial Differential Equations.
2. Finite Difference Methods for Solving Parabolic Partial Differential Equations.
3. Finite Difference Methods for Solving Hyperbolic Partial Differential Equations.
4. To solve transient PDE using Method of Lines.
5. To solve Laplace equation.
6. To solve Poisson equation.
7. To solve one-dimensional wave equation.
8. To solve one dimensional heat conduction equation by i) Explicit and ii) Crank-Nicolson implicit method.
9. To solve First order Quasi –Linear Partial Differential Equation
10. To solve Maximum Principle.
11. General solutions of higher order PDE's with constant coefficients.
12. To solve a PDE via. Method of separation of variables.

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12.Brief Description of self learning / E-learning component
https://www.mathworks.in › ... › Partial Differential Equations https://nptel.ac.in/courses/103106118/ https://nptel.ac.in/courses/103106118/3
13.Books Recommended
8. Jichun Li, Yi-Tung Chen, Computational Partial Differential Equations Using MATLAB,CRC Press, Boca Raton (2008). 9. Randall J. LeVeque, Finite Difference Method for Differential Equations ,Course Notes for A Math 585 , 586, University of Washington , Seattle, 2004. 10. Chapra S.C. and Canale R.P.(2006) Numerical Methods for Engineers, 5th Ed., McGraw Hil. 11. M.D Rai Singhania, Ordinary and Partial Differential Equations Engineers, S. Chand Publishing,2013. 12. T. Amarnath, An Elementary Course in Partial Differential Equations, Narosa Publishing House.

1. Name of the Department: Mathematics						
2. Course Name	Operations Research	**L**	**T**		**P**	
3. Course Code	17070205	4	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 50		**Tutorials = 0**		**Practical = 0**		

8. Course Description:

This Course consists of different areas likes Non Linear Programming, Integer programming, Dynamic Programming, Network Analysis. Above area define various theorem and Techniques for modeling real world problems and method to find their optimal solution

9. Course Objectives:

The objective of this course to emphasizes the application of Operational Research for solving integer programming, dynamic programming and Network analysis. Throughout this course students are expected to know and understand common and important problems. Student will develop problem modelling and solving skills.

10. Course Outcomes (COs):

After Completion of this course the Students will be able to explain the various Techniques of Operational Research. After apply the techniques they will use in real life problems. Students will able to select an optimum solution

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit: Dynamic Programming**
Deterministic and Probabilistic, Dynamics Programming, Game Theory, Two –Person, Zero – Sum Games, Games with Mixed strategies, Graphical Solution, Solution by linear Programming		
Unit - 2	**Number of lectures = 15**	**Title of the unit: Integer Programming**
Branch and Bound Technique, Application to Industrial Problems Optimal product mix and activity levels. Petroleum-Refinery operation, Blending problems. Economic interpretation of dual linear programming problems. Input-Output analysis, Indecomposable and Decomposable economics		
Unit – 3	**Number of lectures = 10**	**Title of the unit: Non Linear Programming and Types of Programming**
One and Multi-Variable Unconstrained Optimization, Kuhn-Tucker Condition for Constrained Optimization Quadratic Programming, Separable Programming, Convex Programming , Non Convex Programming		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Types of Programming and Network Analysis**
Shortest Path Problems, Minimum Spanning Tree problems, Maximum Flow Problems, Minimum Cost Flow Problems, Network Simplex Method, Project Planning and Control with PERT-CPM.		

Basic of Linear Programming

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12. Brief Description of self learning / E-learning component
https://www.youtube.com/watch?v=ug7O11SZyg0 https://www.youtube.com/watch?v=Lt7OZP_F3jY https://www.youtube.com/watch?v=vUMGvpsb8dc
13. Books Recommended
1. FS Hillier and GJ Leiberman: Introduction to Operation Research(Sixth Edition), McGraw – Hill International Edition.This books comes with a CD containing tutorial software 2. G. Hdley: Linear Programming,Narosa Publishing House 1995 3. G. Hadley, Nonlinear and Dynamic Programming , Addison-Wesley,Reading Mass 4. KantiSwarup, P.K. Guptaand Man Mohan, Operational Research, Sultan chand and Sons New Delhi 5. Taha H.A., Operations Research-An Introduction, PHI (2007) 6. S.S. Rao, Optimization Theory and Applications, Wiley Eastern Ltd, New Delhi. 7. Pant J. C., Introduction to optimization: Operations Research, Jain Brothers (2004)

1. Name of the Department: Mathematics						
2. Course Name	Operations Research Lab	**L**	**T**		**P**	
3. Course Code	17070206	4	0		2	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 35**		

8. Course Description:

Operation Research Lab helps the students to understand the beauty of Math application.

Operations Research is a science of modeling and optimization. It allows you to model real-world problems by using mathematics, statistics, and computers. It provides you tools and theories to solve these real-world problems by finding the optimal solutions to the model's subject to constraints of time, labor, resource, material, and business rules. With Operations Research, people make intelligent decisions to develop and manage their processes.

Course Objectives:

This module aims to introduce students to use quantitative methods and techniques for effective decisions making; model formulation and applications that are used in solving decision making problems.

Course Outcomes (COs):

On successful completion of this course, students will be able to:

Solve the problem on the software like (Maxima, LINGO, MAPLE, Mathematica. MATLAB, Python, SciLab)

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OR LAB: At least 10 experiments from the following:

1. To determine the area of LLP by Integer Programming
2. To determine the area by Mixed Integer Programming
3. Solve the Dynamic Optimization on Toolbox on any Mathematical Software
4. To solve the feasible area by using Dynamic Programming.
5. To solve the Multi variable constraint by NLPP
6. To solve the Kuhn-Tucker condition by NLPP
7. To solve the Linear Programing Refinery
8. Solve the matrix programming of Game Theory
9. Solve the area by using Quadratic Programming
10. Explain the application of Nonlinear Programming on any Mathematical software
11. Solve the shortest path by using PERT and CPM.
12. Find the Minimum Spanning Tree on MATLAB
13. To solve the feasible area by using the property of Convex set.
14. Solve the project planning by using PERT and CPM.

Books Recommended

7. FS Hillier and GJ Leiberman: Introduction to Operation Research (Sixth Edition), McGraw – Hill International Edition. This book comes with a CD containing tutorial software
8. G. Hdley: Linear Programming, Narosa Publishing House 1995
9. G. Hadley, Nonlinear and Dynamic Programming, Addison-Wesley, Reading Mass
10. Kanti Swarup, P.K. Gupta and Man Mohan, Operational Research, Sultan chand and Sons New Delhi
11. Taha H.A., Operations Research-An Introduction, PHI (2007)
12. S.S. Rao, Optimization Theory and Applications, Wiley Eastern Ltd, New Delhi.
13. Pant J. C., Introduction to optimization: Operations Research, Jain Brothers (2004)

E-learning resources

https://www.youtube.com/watch?v=yFprG0iJQUE

https://www.youtube.com/watch?v=z4aMBaTPW3I

https://www.youtube.com/watch?v=kavYLZatz44

https://www.youtube.com/watch?v=M_mpRrGKKMo

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1. Name of the Department: Mathematics						
2. Course Name	General Relativity and Cosmology	**L**	**T**		**P**	
3. Course Code	17070207	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 50	**Tutorials = 0**	**Practical = 0**

8. Course Description:

This Course is an introduction to Einstein theory of general relativity and includes application to early Cosmology. This course consist of Special theory of relativity and Newtonian Theory olso discuss about Energy-Momentum tensor of fluid and Bending of light rays in a gravitational field

9. Course Objectives:

The students shall be familiar with the fundamental principal of relativity and cosmology. The students shall master calculation with tensors and differential forms .They also will know about Newtonian theory in details

10. Course Outcomes (COs):

After completed this course student will understand the physical principle which guided Einstein in relativity. They derive the basic concept of cosmology and manipulation tensors. They will be able to understand the key properties of black holes

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit: General Relativity**

Transformation of coordinates, Tensors, Algebra of Tensors, Symmetric and Skew symmetric Tensors, Contraction of Tensors and Quotient law. Riemannian metric, Parallel transport Christoffel symbols, Covariant derivative Intrinsic derivative and Geodesics, Riemann Christoffel curvature tensor and its symmetry.

Unit - 2	**Number of lectures = 15**	**Title of the unit: Special Theory of Relativity and Newtonian Theory**

Review of the special theory of relativity and the Newtonian theory of Gravitation .Principal of equivalence and general covariance, Geodesic principle , Newtonian approximation of relativistic equations of motion, Einstein field equation and Newtonian approximation

Unit - 3	**Number of lectures = 10**	**Schwarzschild Solution and Planetary Orbits**

Schwarzschild external solution and its isotopic form.Planetary orbits and anologues of Kapler law in general relativity, Advance of perihelion of a planet. Bending of light rays in a gravitational field. Vitational redshift of spectral lines. Radar echo delay

Unit - 4	**Number of lectures = 10**	**Title of the unit: Einstien-Maxwell Equation and Energy –Momentum Tensor**

Energy-Momentum tensor of a perfect fluid. Schwarzschild internal solution, Boundary conditions, Energy-momentum tensor of an electromagnetic field. Einstein-Maxwell equation, Reissner-Nordstrom

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solution
12. Brief Description of self learning / E-learning component
https://www.youtube.com/watch?v=Y45lf2xMzjA https://www.youtube.com/watch?v=zH2RsBK7mUg https://www.youtube.com/watch?v=z1AomGV0WHw
13. Books Recommended
1. CE Weatherburn, An Introduction to Riemannian Geometry and tensor calculus,, Cambridge University Press 950. 2. H. Stepheni, General Relativity-An Introduction to the theory of the gravitational field, Cambridge University Press 1982. 3. JV Nar liker, General Relativity and Cosmology, The Macmillan Company of India Ltd 1978. 4. JV Nar liker, Introduction to Cosmology, Cambridge University Press 1993. 5. S. Weinberg, Gravitation and Cosmology :Principles and application of general theory of relativity, John Wiley and Sons 1972

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1. Name of the Department: Mathematics						
2. Course Name	Fuzzy Sets & its Applications	**L**	**T**		**P**	
3. Course Code	17070208	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. re-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 50	**Tutorials = 0**	**Practical = 0**

8. Course Description:

This course provides the fundamentals of classical set theory and fuzzy set theory. The decomposition theorems of fuzzy sets and the extension principle will be introduced, as well as the use of nonlinear integrals as aggregation tools to deal with fuzzy data. As an indispensable tool in fuzzy decision making, ranking and ordering fuzzy quantities will be discussed.

9. Course Objectives:

To provide an understanding of the basic mathematical elements of the theory of fuzzy sets.

To provide an emphasis on the differences and similarities between fuzzy sets and classical sets theories.

To cover fuzzy logic inference with emphasis on their use in the design of intelligent or humanistic systems.

To provide a brief introduction to fuzzy arithmetic concepts.

10. Course Outcomes (COs):

Objectives: Upon successful completion of this course, students should

1. be able to understand basic knowledge of fuzzy sets and fuzzy logic,
2. be able to apply fuzzy inferences,
3. be able to apply fuzzy information in decision making,
4. be able to appreciate the theory of possibility on the basis of evidences.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit: Basic Fuzzy Sets**

Basic definitions, α -level sets, comparison with classical (crisp) sets, Types of fuzzy sets, extension principle, Fuzzy complement, t-norms, t-co-norms, combination of operations, aggregation operations. Fuzzy numbers, linguistic variables, arithmetic operations on intervals, arithmetic operations on fuzzy numbers, lattice of fuzzy numbers, fuzzy equations.

Unit – 2	**Number of lectures = 15**	**Title of the unit: Crisp versus fuzzy relation**

Crisp versus fuzzy relation, projections and cylindrical extensions, binary fuzzy relations, binary relations on a single set, fuzzy equivalence relations, fuzzy compatibility and fuzzy ordering relations. Fuzzy measures, evidence theory, possibility theory, fuzzy sets and possibility theory. Max. Min operat

Unit – 3	**Number of lectures = 10**	**Title of the unit: Fuzzy Logic**

An overview of classical logic, multi valued logic, fuzzy propositions, fuzzy quantifiers, and linguistic hedges, Inference from conditional fuzzy propositions, Inference from conditional and qualified

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Unit – 4	Number of lectures = 12	Applications

Individual, multiperson, multicriteria decision making, fuzzy ranking method, fuzzy linear programming. Methods of de-fuzzyfication and fuzzification, Mamdami model

12. Brief Description of self-learning / E-learning component

https://cours.etsmtl.ca/sys843/REFS/Books/ZimmermannFuzzySetTheory2001.pdf

https://www.worldscientific.com/worldscibooks/10.1142/2867#t=toc

https://www.tutorialspoint.com/fuzzy_logic/fuzzy_logic_set_theory.htm

13. Books Recommended

1. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall of India, New Delhi.
2. Chandra Mohan, An Introduction to Fuzzy Set Theory and Fuzzy Logic, 2015, Viva Books Private Limited (2015)
3. H.J. Zimmermann, Fuzzy Set Theory & its Applications, Allied Publishers Ltd. New Delhi.
4. Timothy J. Ross, Fuzzy Logic with Engineering Applications, McGraw Hills inc. New Delhi

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1. Name of the Department: Mathematics						
2. Course Name	Linear Algebra	**L**	**T**		**P**	
3. Course Code	17070301	4	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 50		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

Linear Algebra cover the following points:

1. Matrices, Determinants and Vector spaces
2. Linear Transformation and Inner Product Spaces
3. Diagonalization
4. Intoduction to Bilinear and Quadratic Forms.

9. Course Objectives:

1. To Familiarize Students With A Sound Knowledge And Understanding Of The Concepts Of Linear Algebra, Fundamentals Of Algebra, Notation And Its Calculation Applications.
2. To Make Students Aware Of Proficeiency In Applying Techniques From Linear Algebra, The Field Of Matrices And Linear Spaces
3. To Train Skills Of Application Of Appropreiate Techniques From Linear Algebra To Real World Problems, Correct Formulas And Relations For Calculations
4. To Train Solving Problems And Exercises Concerning Vectors, Matrices, And Linear Spaces
5. To Familiarize Students To Communicate Mathematical Ideas, Processes And Results Effectively At Different Levels Of Formality.

10. Course Outcomes (Cos):

On Completion Of The Course The Student Shall Be Able To:

1. Be Able To Give An Account Of And Use Basic Vector Space Concepts Such As Linear Space, Linear Dependence, Basis, Dimension, Linear Transformation;
2. Be Able To Give An Account Of And Use Basic Concepts In The Theory Of Finite Dimensional Euclidean Spaces;
3. Be Familiar With The Concepts Of Eigenvalue, Eigenspace And Eigenvector And Know How To Compute These Objects;
4. Know The Spectral Theorem For Symmetric Operators And Know How To Diagonalise

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Quadratic Forms In ON-Bases;

5. Know How To Solve A System Of Linear Differential Equations With Constant Coefficients;
6. Be Able To Formulate Important Results And Theorems Covered By The Course;
7. Be Able To Use The Theory, Methods And Techniques Of The Course To Solve Mathematical Problems;

11. Unit wise detailed content

Unit – 1	**Number of lectures = 10**	**Title of the unit: Matrices, Determinants and Vector spaces**

Matrices: Elementary matrices, invertible matrices, Gauss-Jordon method, determinant, Systems of linear equations and Cramer's Rule. Vector spaces: Fields, Vector spaces over a field, subspaces, Linear independence and dependence, existence of basis, coordinates, dimension.

Unit-2	**Number of lectures = 15**	**Title of the unit: Linear Transformation and Inner Product Spaces**

Linear Transformations: Rank Nullity Theorem, isomorphism, matrix representation of linear transformation, change of basis, similar matrices, linear functional and dual space. Inner product spaces: Cauchy-Schwarz's inequality, Gram-Schmidt orthonormalization, orthonormal basis, orthogonal projection, projection theorem, four fundamental subspaces and their relations (relation between null space and row space; relation between null space of the transpose and the column space).

Unit – 3	**Number of lectures = 15**	**Title of the unit: Diagonalization**

Diagonalization: Eigenvalues and eigenvectors, diagonalizability, Invariant subspaces , adjoint of an operator, normal, unitary and self adjoint operators, Schur's Lemma, diagonalization of normal matrices, spectral decompositions and spectral theorem, applications of spectral theorem, Cayley-Hamilton theorem, primary decomposition theorem, Jordon canonical form, minimal polynomials,

Unit – 4	**Number of lectures = 10**	**Title of the unit: Intoduction to Bilinear and Quadratic Forms.**

Introduction to bilinear and Quadratic forms: Bilinear and quadratic forms, Sylvester's law of inertia. Some applications: Lagrange interpolation, LU,QR and SVD decompositions, least square solutions, least square fittings, pseudo inverses.

12. Brief Description of self learning / E-learning component

1. http://home.iitk.ac.in/~arlal/book/nptel/pdf/booklinear.html
2. http://www.maths.qmul.ac.uk/~pjc/notes/linalg.pdf
3. http://www.mathe2.uni-bayreuth.de/stoll/lecture-notes/LinearAlgebra1.pdf
4. https://www.cs.cornell.edu/courses/cs485/2006sp/LinAlg_Complete.pdf

13. Books Recommended:

1. Kenneth Hoffman and Ray Kunze: Linear Algebra, PHI publication.
2. Gilbert Strang: Linear Algebra and Its Applications, 4th edition.
3. Sheldon Axler: Linear Algebra Done Right, UTM, Springer.

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1. Name of the Department: Mathematics						
2. Course Name	Topology	**L**	**T**		**P**	
3. Course Code	17070302	4	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 50		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

The course unit aims to introduce the basic ideas of Topological spaces. This course is designed as a basic introductory course in the analysis of metric.

9. Course Objectives:

The objectives of this course are to:

1. To introduce students to the concepts of open and closed sets not necessarily only on the real line approach.
2. To introduce the students about applications of above to proving continuous functions.
3. To introduce the students how to generate new topologies from a given set with bases.
4. To provide the awareness of tools for students to carrying out advanced research work in Pure mathematics.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. distinguish among open and closed sets on different topological spaces;
2. Know the two fundamental topologies: discrete and indiscrete topologies.
3. identify precisely when a collection of subsets of a given set equipped with a topology forms a topological space;
4. understand when two topological spaces are homeomorphic
5. identify the concepts of distance between two sets; connectedness, denseness, compactness and separation axioms

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit: Topological Space**

Definition and examples of topological space, Door space, Closed sets, Closure, Dense subset, Neighborhoods, interior, exterior, boundary and accumulation points, Derived sets, Bases and sub-bases, Subspaces, product spaces and relative topology.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Continuous Functions &Connectedness**

Continuous functions, homeomorphisms, the pasting lemma, properties of continuous fnctions, open & closed mappings, Connected and disconnected sets, connectedness on the real line, components, locally connected spaces.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Compactness**

Compactness – Continuous functions and compact sets, basic properties of compactness, compactness and finite intersection property, sequentially and countably compact sets, local compactness.

Unit – 4	Number of lectures = 15	Title of the unit: Separation Axioms

First countable space, second countable space and Separable space, Lindelof's theorems Separation axioms – T_0, T_1, T_2, T_3, $T3_{½}$, T_4, their characterizations and basic properties. Urysohn's lemma and Teitze extension theorem, Statement of Urysohn's metrization theorem, Statements of Tychonoff's product theorem and Stone-cechcompactification theorem.

12. Brief Description of self-learning / E-learning component

https://wolfweb.unr.edu/homepage/jabuka/Classes/2009_spring/topology/Notes/02%20%20Topological%20spaces.pdf

http://www.math.muni.cz/~koren/EssentialTopology.pdf

http://home.iitk.ac.in/~chavan/topology_mth304.pdf

http://nptel.ac.in/courses/111106054/Chapter3.pdf

13. Books Recommended:

1. J. R. Munkres, Topology, A First Course, PHI Pvt. Ltd., N. Delhi, 2000.
2. Misney A. Morris, "Topology without Tears, 2011.
3. S. Willard, General Topology, Addison-Wesley, Reading, 1970.
4. W. J. Pervin, Foundations of General Topology, Academic Press Inc., New York, 1964.
5. J. Dugundji, Topology, Allyn and Bacon, 1966 (Reprinted in India by PHI).
6. G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.
7. K.P. Gupta, Topology, Pragati Prakashan, 2015.
8. K D Joshi, Introduction to General Topology, Wiley Eastern Ltd., 1983

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1. Name of the Department: Mathematics						
2. Course Name	Statistical Inference	**L**	**T**		**P**	
3. Course Code	17070303	4	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 50	**Tutorials = 0**	**Practical = 0**

8. Course Description:

This course introduces students to the basic theory behind the development and assessment of statistical analysis techniques in the areas of point and interval estimation, as well as hypothesis testing.

Topic includes:Point estimation and interval methods, including method of moments and maximum likelihood, unbiasedness, consistency, efficiency and sufficiency, hypothesis testing methods including parametric and nonparametric approaches and related confidence interval.

9. Course Objectives:

Upon successful completion of this course:

1. The students should be familiar with the concept of statistical inference and has knowledge about the construction of point and interval estimators, hypothesis testing and interval estimation under a large variety of discrete and continuous probability models.
2. The students should be familiar with the common probability distributions that are used in statistical inference
3. Further, the student can evaluate the properties of these estimators and tests, for both finite sample sizes and asymptotically as the sample size tends to infinity.
4. Lastly, the student has insight in how to construct optimal estimators and tests

10. Course Outcomes (COs):

Upon successful completion of this course, students should have the knowledge and skills to:

1. Explain the notion of a parametric model and point estimation of the parameters of those models.
2. Explain and apply approaches to include a measure of accuracy for estimation procedures and our confidence in them by examining the area of interval estimation.
3. Asses the plausibility of pre-specified ideas about the parameters of a model by examining the area of hypothesis testing.
4. Explain and apply the idea of non-parametric statistics, wherein estimation and analysis techniques are developed that are not heavily dependent on the specifications of an underlying parametric model.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Theory of Estimation**

Point and interval estimation, criterion of a good estimator - unbiasedness, consistency, efficiency and sufficiency, Methods of estimation- method of maximum likelihood and method of moments.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Testing of Hypothesis (Large Sample Test)**

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Statistical hypothesis, Null and alternative hypotheses, simple and composite hypotheses, critical region, level of significance, one tailed and two tailed tests, two types of errors, Neyman-Pearson lemma, large sample tests for single mean, single proportion, difference between two means and two proportions and related confidence intervals

Unit - 3	Number of lectures = 15	Title of the unit: Testing of Hypothesis (Small Sample Test)

Definition of Chi-square statistic, Chi-square tests for goodness of fit and independence of attributes. Definition of Student's 't' and Snedecor's F-statistics, testing for the mean and variance of univariate normal distributions, testing of equality of two means and two variances of two unilabiate normal distributions and related confidence intervals.

Unit - 4	Number of lectures = 15	Title of the unit: Non Parametric Test

Non Parametric Tests: One sample and paired sample problems, Sign Test, Wilcoxon Signed ranked test and their comparison, Wald-Wolfwitz Run test, Mann Whiteney-U test, Median test.

12. Brief Description of self learning / E-learning component

http://nptel.ac.in/courses/111105043/

https://www.youtube.com/watch?v=iin6vthyzsQ&list=PLbMVogVj5nJRkNUH5v9qNEJvW7r2A7rEY

https://www.youtube.com/watch?v=IEP3swFeauE

13. Books Recommended

1. Lehman, E.L., Testing of Statistical Hypothesis, Wiley Eastern Ltd, 1959
2. Lehman, E.L., Point Estimation, John Wiley & sons 1984
3. Rohatgi, V.K., Statistical Inference, Dover Publications 2011
4. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, S. Chand Pub.,2014
5. Gibbons, J.D., Non-parametric Statistical Inference, McGraw Hill Inc. 1971
6. A.M. Goon, M.K. Gupta, and B. Das Gupta, Fundamentals of Statistics, Vol-II.

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1. Name of the Department: Mathematics							
2. Course Name	Statistical Inference Lab	**L**	**T**		**P**		
3. Course Code	17070304	0	0		4		
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical							
Lectures = 0		**Tutorials = 0**		**Practical =35**			

8. Course Description:

This course introduces students to the basic theory behind the development and assessment of statistical analysis techniques in the areas of point and interval estimation, as well as hypothesis testing.

Topic includes:Point estimation and interval methods, including method of moments and maximum likelihood, unbiasedness, consistency, efficiency and sufficiency, hypothesis testing methods including parametric and nonparametric approaches and related confidence interval.

9. Course Objectives:

Upon successful completion of this course:

5. The students should be familiar with the concept of statistical inference and has knowledge about the construction of point and interval estimators, hypothesis testing and interval estimation under a large variety of discrete and continuous probability models.
6. The students should be familiar with the common probability distributions that are used in statistical inference
7. Further, the student can evaluate the properties of these estimators and tests, for both finite sample sizes and asymptotically as the sample size tends to infinity.
8. Lastly, the student has insight in how to construct optimal estimators and tests

10. Course Outcomes (COs):

Upon successful completion of this course, students should have the knowledge and skills to:

5. Explain the notion of a parametric model and point estimation of the parameters of those models.
6. Explain and apply approaches to include a measure of accuracy for estimation procedures and our confidence in them by examining the area of interval estimation.
7. Asses the plausibility of pre-specified ideas about the parameters of a model by examining the area of hypothesis testing.
8. Explain and apply the idea of non-parametric statistics, wherein estimation and analysis techniques are developed that are not heavily dependent on the specifications of an underlying parametric model.

11. Statistical Inference Lab Syllabus:

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Practical Based on Syllabus: Programming in "C" or Applying software packages for problems based on Theory paper Statistical Inference (08030305).

Use of Statistical Software packages such as MINITAB, SPSS, Statgraf etc.

Practical Exercises for Statistical techniques based on topics in paper Statistical Inference (08030305).

Note:

1. At least eight experiments are to be performed in the semester.

2. At least three experiments are based on Software and remaining experiments are based on conventional methods.

3. At least six experiments should be performed from the above list. Remaining two experiments may either be performed from the above list or designed & set by the department as per the scope of the syllabus.

12. Brief Description of self learning / E-learning component

http://nptel.ac.in/courses/111105043/

https://www.youtube.com/watch?v=iin6vthyzsQ&list=PLbMVogVj5nJRkNUH5v9qNEJvW7r2A7rEY

https://www.youtube.com/watch?v=IEP3swFeauE

13. Books Recommended

7. Lehman, E.L., Testing of Statistical Hypothesis, Wiley Eastern Ltd, 1959
8. Lehman, E.L., Point Estimation, John Wiley & sons 1984
9. Rohatgi, V.K., Statistical Inference, Dover Publications 2011
10. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, S. Chand Pub.,2014
11. Gibbons, J.D., Non-parametric Statistical Inference, McGraw Hill Inc. 1971
12. A.M. Goon, M.K. Gupta, and B. Das Gupta, Fundamentals of Statistics, Vol-II.

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1. Name of the Department: Mathematics						
2. Course Name	Numerical Analysis and its Applications	**L**	**T**		**P**	
3. Course Code	17070305	4	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 50		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

Numerical Analysis and its Applications cover the following points:

5. Basics of Numerical Analysis
6. System of Linear Algebraic Equations and Eigen Value Problems
7. Numerical Solution Of Ordinary Differential Equations
8. Numerical Solution Of Partial Differential Equations

9. Course Objectives:

Numerical Methods is a powerful problem solving tools in it student is capable to solve different problems analytically like Linear Equations, ODE, PDE, Differentiations and Integrations, Interpolation.

10. Course Outcomes (COs):

On completion of this course students will able to:

8. Student will know about the Basics of Numerical Analysis
9. Student will be able to understand System of Linear Algebraic Equations and Eigen Value Problems
10. Student will be able to understand Numerical Solution Of Ordinary Differential Equations
11. Student will be able to understand Numerical Solution Of Partial Differential Equations .

11. Unit wise detailed content

Unit – 1	**Number of lectures = 10**	**Title of the unit: Basics of Numerical Analysis**
Finite difference operators, Basics of Numerical Differentiation and Integration,Relaxation method and its convergence, Muller's method for complex and multiple roots, Cubic Spline, Romberg's Integration, Richardson's Extrapolation.		
Unit-2	**Number of lectures = 10**	**Title of the unit: System of Linear Algebraic Equations and Eigen Value Problems**

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Direct Methods, Error Analysis for Direct Methods, Eigen Values and Eigen vectors, Bounds on Eigen Values, Jacobi, Givens and Housholder's Methods for Symmetric Matrices, Rutishauser Method for Arbitrary Matrices, Power and Inverse Power methods, Choice of a Method.		
Unit – 3	**Number of lectures = 15**	**Title of the unit: Numerical Solution Of Ordinary Differential Equations**
Introduction. Runge Kutta methods derivation, error bounds and error estimates. Weak stability theory for Runge Kutta methods. Order and convergence of the general explicit one step methods. Linear multi step methods derivation, order consistency, zero stability and convergence. Weak stability theory for general linear multi step methods. Predictor Corrector methods, Stiff systems.		
Unit – 4	**Number of lectures = 15**	**Title of the unit: Numerical Solution Of Partial Differential Equations**
Basic linear algebra vector and matrix norms and related theorems. Parabolic equations in one and two space dimensions explicit and implicit formulae. Consistency, stability and convergence. Iterative methods for linear systems. Split operator methods. Multilevel difference schemes. Nonlinear equations. Elliptic Equations Dirichlet, Neumann and mixed problems. Direct factorization methods and successive over relaxation (S.O.R.). ADI and conjugate gradient methods. Hyperbolic equations. First order hyperbolic systems in one and two space dimensions stability and convergence. Second order equations in one and two space dimensions. The Galerkin method and applications.		
12. Brief Description of self learning / E-learning component		
www.youtube.com/watch?v=QQFIWwDA9NM&index=4&list=PLbMVogVj5nJRILpJJO7KrZa8Ttj4_ZAgl www.youtube.com/watch?v=rj2Mb7JGyHk&index=23&list=PLbMVogVj5nJRILpJJO7KrZa8Ttj4_ZAgl www.youtube.com/watch?v=rMC6yvc7a6s&list=PLbMVogVj5nJRILpJJO7KrZa8Ttj4_ZAgl&index=27 www.youtube.com/watch?v=9YWjoiE4Wck&list=PLbMVogVj5nJRILpJJO7KrZa8Ttj4_ZAgl&index=33		
13. Books Recommended:		
1. B.S. Grewal, "Numerical Methods in Engineering & Science", Khanna Publication, Ed. 9th. 2. E. Balagurusamy , "Numerical Method", Tata McGraw Hill Publication. 3. S.S. Sastry, "Introductory Methods of Numerical Analysis", PHI learning Pvt. Ltd. 4. Curtis F. Gerald and Patrick O. Wheatley, "Applied Numerical Analysis", Pearson Education. 5. M.K Jain, S. R. K. Iyengar and R.K Jain, "Numerical Methods for Scientific and Engineering computation", New age International Publishers. 6. V. Sundarapandian, "Numerical Linear Algebra", PHI Learning Private Limited, Delhi.		

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1. Name of the Department: Mathematics						
2. Course Name	Numerical Analysis and its Applications Lab	**L**	**T**		**P**	
3. Course Code	17070306	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures =		**Tutorials = 0**	**Practical = 35**			

8. Course Description:

This course analyzed the basic techniques for the efficient numerical solution of problems in science. Topics s covered are: matrix operations, linear equation, Solution of Linear equations for Underdetermined and Overdetermined cases, Eigen values and Eigen vectors of a Square matrix, Solution of Difference Equations, Solution of Difference Equations using Euler and Modified Euler Method, Solution of differential equation using 4th order Runge- Kutta method, Roots of a polynomial, Polynomial using method of Least Square Curve Fitting, Polynomial using method of Least Square Curve Fitting, Polynomial fit, analyzing residuals, exponential fit and error bounds from the given data, Solution of Non-linear equation in single variable using the method of successive bisection

9. Course Objectives:

Many applications in engineering, physics, geology and other specifications containing complicated problems that will require one of the numerical methods to be solved. In this course students will learn the classification of many complicated problems and the suitable numerical methods for obtaining an approximated solution to these problems with desired accuracy.

10. Course Outcomes (COs):

On completion of this course, the students will learn

1. Practical and theoretical knowledge of a range of matrix operations.
2. Practical and theoretical knowledge of Linear equations for Underdetermined and Overdetermined cases.
3. Practical and theoretical knowledge of Eigen values and Eigen vectors of a Square matrix.
4. Practical and theoretical knowledge of schemes polynomial fit, analyzing residuals, exponential fit and error bounds from the given data.

11. The list of practical's to perform in the computer lab

1. Study of basic matrix operations

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2. To solve linear equation
3. Solution of Linear equations for Underdetermined and Overdetermined cases.
4. Determination of Eigen values and Eigen vectors of a Square matrix.
5. Solution of Difference Equations.
6. Solution of Difference Equations using Euler Method.
7. Solution of differential equation using 4th order Runge- Kutta method.
8. Determination of roots of a polynomial.
9. Determination of polynomial using method of Least Square Curve Fitting.
10. Determination of polynomial fit, analyzing residuals, exponential fit and error bounds from the given data.
11. Solution of Non-linear equation in single variable using the method of successive bisection.

12. Brief Description of self learning / E-learning component

http://gnindia.dronacharya.info/CSEIT/Downloads/Labmanuals/Lab_Manual_Numerical_Technique.pdf

http://www.ycetnnl.edu.in/downloads/files/n532957dd8a753.pdf

https://www.youtube.com/watch?v=FoukIaj5pP8

13. Books Recommended:

7. B.S. Grewal, "Numerical Methods in Engineering & Science", Khanna Publication, Ed. 9th.
8. E. Balagurusamy , "Numerical Method", Tata McGraw Hill Publication.
9. S.S. Sastry, "Introductory Methods of Numerical Analysis", PHI learning Pvt. Ltd.
10. Curtis F. Gerald and Patrick O. Wheatley, "Applied Numerical Analysis", Pearson Education.
11. M.K Jain, S. R. K. Iyengar and R.K Jain, "Numerical Methods for Scientific and Engineering computation", New age International Publishers.
12. V. Sundarapandian, "Numerical Linear Algebra", PHI Learning Private Limited, Delhi.

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1. Name of the Department: Mathematics						
2. Course Name	Differential Geometry	**L**	**T**		**P**	
3. Course Code	17070307	2	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 30	**Tutorials = 0**	**Practical = 0**

8. Course Description:

This course comprises application of calculus and Algebra to the geometry of curves and surfaces in spaces. This course consist of Tensor , Riemann Chrisoffel and Metric space , Tangent space, Different types of Curvature and Involutes

9. Course Objectives:

The objective of this course is to **provide the basics geometric concepts of curves, surfaces and tensors.**

10. Course Outcomes (COs):

After completion the syllabus student will be able to explain the concept of different types of curves and its role in Modern Mathematics. Apply the Differential Geometry techniques to specific research problems in Mathematics

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Theory of Space Curves**

Space curves, Planer curves, Curvature, Torsion and Serret-Frenet formulae. Osculating circles, and spheres. Existence of space curves. Evolutes and involutes of curves.

Unit - 2	**Number of lectures = 15**	**Theory of Surfaces**

Parametric curves on surfaces. Direction coefficients. First and second Fundamental forms. Principal and Gaussian curvatures. Lines of curvature, Eulers theorem. Rodrigues formula, Conjugate and Asymptotic lines.

12. Brief Description of self learning / E-learning component

http://strangebeautiful.com/other-texts/spivak-intro-diff-geom-v1-3ed.pdf

http://www2.ing.unipi.it/griff/files/dC.pdf

https://fsw01.bcc.cuny.edu/luis.fernandez01/web/texts/dgcs.pdf

http://web.math.ku.dk/noter/filer/geom1.pdf

http://people.math.aau.dk/~raussen/INSB/AD2-11/book.pdf

13. Books Recommended

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12. A. Goetz: Introduction to Differential Geometry : Addition Wesley Publishing Company 1970
13. Willmore, T. J., An Introduction to Differential Geometry", Dover publications, 2012.
14. Lang, S., Fundamentals of Differential Geometry", Springer, 1999.
15. Spain, B., Tensor Calculus: A concise Course", Dover Publications, 2003.
16. Struik, D., J., Lectures on Classical Differential Geometry", Dover Publications, 1988.
17. Shanti Narayan : Cartesian Tensors, S.,Chand and Company, New Delhi

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1. Name of the Department: Mathematics						
2. Course Name	Discrete Mathematics and Automata	**L**	**T**		**P**	
3. Course Code	170701308	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 50		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

Introduction to discrete structures and their applications like logic, gate and set theory, recursive programming, digital logic and combinatorial circuits, real number representation and finite automata used in computer science.

9. Course Objectives:

To provide basic and theoretical competencies that ismajorly used in Computer Science. To help students understand and appreciate the basic mathematical knowledge which is fundamental to Computer Science.

10. Course Outcomes (COs):

Determination of the logical equivalence of propositions and the validity of formal arguments via truth tables. Design and construction of a combinatorial circuit from a verbal description. Finite automata are able to construct a recognizer simple language.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit: Logics, Algebraic Struture and Lattices**

Formal Logic: Statement, Symbolic representation, totologies, quantifiers, pradicates and validity, propositional logic. Semigroups and Monoids: Definitions and examples of semigroups and monoids (including those pertaining to concentration operations). Homomorphism of semigroups and monoids, Congurence relation and quotient semigroups, sub semigropups and sub monoids, Direct products basic homomorphism theorem. Lattices: Lattices as partially ordered sets, their properties. Lattices and algebraic systems.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Boolean Algebra**

Boolean Algebra: Boolean Algebra as Lattices. Various Boolean Identities Join-irreducible elements. Atoms and Minterms. Boolean Forms and their Equivalence. Minterm Boolean Forms, Sum of Products Canonical Forms. Minimization of Boolean Functions. Applications of Boolean Algebra to Switching Theory (using AND, OR and NOT gates). The Karnaugh Map method.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Graph Theory.**

Graph Theory – Definition of (undirected) Graphs, Paths, Circuits, Cycles and Subgroups. Induced Subgraphs. Degree of a vertex. Connnectivity. Planar Graphs and their properties. Trees, Spanning Trees. Minimal Spanning Trees and Kruskal'sAlgorithum. Matrix Representations of Graphs. Euler's Theorem on the Existence of Eulerian Paths and Circuits. Directed Graphs. Indegree and Outdegree of a Vertex. Weighted undirected Graphs.

Unit – 4	**Number of lectures = 15**	**Title of the unit: Theory of Automata**

Introductory Computability Theory – Finite state machines and their transition table diagrams. Equivalence of finite state machines. Reduced Machines, Homomorphism. Finite automata. Acceptors.

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Moore and Mealy Machines.
12. Brief Description of self learning / E-learning component
www.youtube.com/watch?v=7k4Di5u-oUU&index=12&list=PL0862D1A947252D20 www.youtube.com/watch?v=_BIKq9Xo_5A&index=13&list=PL0862D1A947252D20 www.youtube.com/watch?v=RMLR2JHHeWo&list=PL0862D1A947252D20&index=14 www.youtube.com/watch?v=fZqfkJ-cb28&list=PL0862D1A947252D20&index=17 www.youtube.com/watch?v=Fk8nJjzohr8&index=22&list=PL0862D1A947252D20
13. Books Recommended
1. Discrete Mathematics , M.K. Venkataraman, The National Publishing Company 2. Discrete Mathematical Structures with Applications to Computer Science J.P. Trembly and Manohar, Tata McGraw-Hill Publications. 3. Elements of Discrete Mathematics, Liu, Tata Mac Graw Hills. 4. Kolman B, Busby R.C. and Ross S., Discrete Mathematical Structures for Computer Science, Fifth Edition, Prentice Hall of India, New Delhi, 2006. 5. Baburam, Discrete Mathematics , Pearson Education 2010

Anjana Gupta – Discrete Mathematics, Katania Publication,

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1. Name of the Department: Mathematics						
2. Course Name	Integral Equations & Calculus of Variation	**L**	**T**		**P**	
3. Course Code	17070309	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 50	**Tutorials = 0**	**Practical = 0**

8. Course Description:

This course contains Fredholm and Volterra integral equations and their solutions using various methods such as Neumann series, resolvent kernels, Euler's equation, variational derivative and invariance of Euler's equations.

9. Course Objectives:

The objectives of this course are to:

1. give an account of the foundations of Integral Equations and calculus of variations and their applications in mathematics;
2. solve simple initial and boundary value problems by using several variable calculus.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Understand different kinds of **Fredholm and Voltera** Integral equations.
2. Orthonormal systems of functions in Integral equations
3. Different methods in Calculus of variations.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit: Definitions, classifications and Eigen functions of integral equations**

Definitions of integral equations and their classification, Relation between integral and differential equations, Fredholm integral equations of second kind with separable kernels, Reduction to a system of algebraic equations. Eigen values and eigen functions, iterated kernels, iterative scheme for solving Fredholm integral equation of second kind (Neumann series), Resolvent kernel, Application of iterative scheme to Volterra's integral equation of second kind.

Unit – 2	**Number of lectures = 10**	Title of the unit: **Hilbert Schmidt theory**

Hilbert Schmidt theory, symmetric kernels, Orthonormal systems of functions. Fundamental properties of Eigen values and Eigen functions for symmetric kernels. Solution of integral equations by using Hilbert Schmidt theory.

Unit – 3	**Number of lectures = 10**	Title of the unit: Calculus of Variation

Introduction to Calculus of Variations, Review of basic multi-variable calculus, constrained maxima and minima, Lagrange multipliers. The Euler-Lagrange equation. Variational problem with moving boundaries: Transversality conditions, one sided variations.

Unit – 4	**Number of lectures = 15**	Title of the unit: Extremum and Canonical transformations

General definitions, Jacobi condition, Weirstrass function, Legendre condition, principle of Least action, Lagrange's equation from Hamilton's principle. Canonical transformation, Direct Methods in variational problems, Ritz, method, Galerkin's method, Collection method and Least square method.

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12. Brief Description of self learning / E-learning component
http://nptel.ac.in/courses/111104025/NPTEL-CoV-IE-Solutions.pdf http://nptel.ac.in/courses/111104025/NPTEL-CoV-IE-Problems.pdf http://www.nptelvideos.in/2012/12/calculus-of-variations-and-integral.html
13. Books Recommended
1. A. S. Gupta, Calculus of Variations with Applications, PHI Learning, 2015. 2. Pundir, S and Pundir S., Calculus of Variation, Pragati Prakashan, Fifth edition 2015. 3. R. P. Kanwal, Linear Integral Equation, Theory and Technique, Academic Press New York 1971. 4. M.D. Rai Singhania, Integral Equations, Pragati Prakashan.

1. Name of the Department: Mathematics						
2. Course Name	Functional Analysis	**L**	**T**		**P**	
3. Course Code	17070401	4	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 50	**Tutorials = 0**	**Practical = 0**

8. Course Description:

This course is for students who are majors in pure mathematics or who need functional analysis in their applied mathematics courses. Functional analysis is the branch of mathematics concerned with the study of spaces of functions. This course is intended to introduce the student to the basic concepts and theorems of functional analysis and its applications.

9. Course Objectives:

The objective of the module is to study linear mappings defined on Banach spaces and Hilbert spaces, especially linear functionals (realvalued mappings) on L(p), C[0, 1] and some sequence spaces. In particular, the four big theorems in functional analysis, namely, Hahn-Banach theorem, uniform boundedness theorem and open mapping theorem will be covered

10. Course Outcomes (COs):

By the end of this course, students should be able to:

1. describe properties of normed linear spaces and construct examples of such spaces
2. extend basic notions from calculus to metric spaces and normed vector spaces
3. state and prove theorems about finite dimensionality in normed vector spaces
4. prove that a given space is a Hilbert spaces or a Banach Spaces
5. describe the dual of a normed linear space
6. state and prove the Hahn-Banach theorem.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit:Normed Linear Spaces**

Normed linear spaces, Metric on normed linear spaces, Completion of a normed space, Banach spaces, subspace of a Banach space, Holder and Minkowski inequality, Completeness of quotient spaces of normed linear spaces. Completeness of lp, Lp ,Rn , Cn and C[a,b]. Incomplete normed space

Unit – 2	**Number of lectures = 15**	**Title of the unit:Bounded Linear Transformations**

Finite dimensional normed linear spaces and Subspaces, Bounded linear transformation, Equivalent formulation of continuity, Spaces of bounded linear transformations, Continuous linear functional, Conjugate spaces. Hahn-Banach extension theorem (Real and Complex form).

Unit – 3	**Number of lectures = 10**	**Title of the unit:Bounded Linear Functionals**

Riesz Representation theorem for bounded linear functionals on Lp and C[a,b]. Second conjugate spaces, Reflexive space, Uniform boundedness principle and its consequences, Open mapping theorem and its application, Projections, Closed Graph theorem.

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Unit – 4	Number of lectures = 10	Title of the unit:Banach Spaces
Equivalent norms, Weak and Strong convergence, Their equivalence in finite dimensional spaces. Weak sequential compactness, Solvability of linear equations in Banach spaces. Compact operator and its relation with continuous operator, Compactness of linear transformation on a finite dimensional space, Properties of compact operators, Compactness of the limit of the sequence of compact operators.		
12. Brief Description of self learning / E-learning component		
http://www.nptelvideos.com/lecture.php?id=13908 https://link.springer.com/book/10.1007/978-3-319-06728-5		
13. Books Recommended		
1. H.L. Royden, Real Analysis, MacMillan Publishing Co., Inc., New York, 4 th Edition, 1993. 2. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley. 3. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963. 4. A. H. Siddiqi, Khalil Ahmad and P. Manchanda, Introduction to Functional Analysis with Applications. 5. K.C. Rao, Functional Analysis, Narosa Publishing House, Second edition.		

1. Name of the Department: Mathematics						
2. Course Name	Number Theory	**L**	**T**		**P**	
3. Course Code	17070402	4	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 50		**Tutorials = 0**		**Practical = 0**		

8. Course Description:

Number Theory is a thriving and active area of research whose origin are amongst the oldest in mathematics. This course consists of Fermat numbers and Farey series and Square theorem. This course also consist of Quadratic Residues and Group Congruence

9. Course Objectives:

The objective of this course is to provide students the basic concept of numbers and their properties. Students will know the detail concept of Congruence and Quadratic Residues

10. Course Outcomes (COs):

On the Completion of this course Students will be able to solve the linear Congruence. Students will also know the lower bound details and Chinese Remainder Theorem its extensions

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Fermat and Farey Series and Details**

Distribution of the prime, Fermat and Mersenne numbers, Farey series and some result concerning Farey series. Approximation of irrational numbers by rations, Hurwitz Theorem

Unit - 2	**Number of lectures = 18**	**Square Theorems and Lower Bound Details**

Diophantine equation $ax+by= cx^2+ y^2= z^2$, $x^4+y^4=z^4$ the representation of number by two or four squares. Warig s problem, Four square theorem, the numbers g(k) & G(K), Lower bound for *g(k) & G(k)*. Simultaneous linear and non linier congruences, Chinese Remainder Theorem and its extension.

Unit - 3	**Number of lectures = 10**	**Quadratic Residues and Group Congruence's**

Quadratic residues and non-residues. Legendre Symbol, Gauss lemma and its application. Quadratic Law of Reciprocity Jacobi Symbol, The arithmetic in Zn. The group congruence's with prime power modulus, primitive roots and their existence

Unit - 4	**Number of lectures = 10**	**Riemann Zeta Function**

Riemann Zeta Function (s) and its convergence. Application to prime numbers. (s) as Euler's, product. Evaluation of (2) and (2k). Dirichlet series with simple properties. Euler's products and Dirichlet products, Introduction to modular forms.

12. Brief Description of self-learning / E-learning component

https://www.youtube.com/watch?v=SCvtxjpVQms

https://www.youtube.com/watch?v=QgPfagOgOAc

13. Books Recommended

1. G.H Hardy and E.M Wright, An Introduction to the theory of Numbers
2. D.M.Burton, Elementary Number Theory
3. N.H.McCoy, The Theory of Numbers, London McMilan
4. I.Niven and H.S.Zuckermann, An Introduction to the theory of Numbers

1. Name of the Department: Mathematics						
2. Course Name	Mathematical Programming and its Application	**L**	**T**		**P**	
3. Course Code	17070403	4	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 50		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

This course presents the theory and application of Mathematical Programming. It extents the theory of optimization methods to more realistic problems

9. Course Objectives:

Students will be able to understand

1. Describe non-linear programming problems.
2. Distinguish non-linear and linear programming problems.
3. Classifies the non-linear programming problems

10. Course Outcomes (COs):

After completing this course students will be able to

1. Solve problems involving optimization models with integer constraints.
2. Have deep insight in solving optimization problems which are non-linear.
3. Distinguish between "single objective" and "multiple objective" functions

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit: Convex functions**

Convex sets, convex functions, pseudo-convex functions, quasi-convex, explicit quasi-convex, quasi-monotonic functions and their properties from the point of view of mathematical programming. Kuhn-Tucker conditions of optimality.

Unit – 2	**Number of lectures = 10**	**Title of the unit:Duality Theory**

Theory of revised simplex algorithm. Duality theory of linear programming. Sensitivity analysis.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Parametric linear programming**

Parametric linear programming. Integer programming and linear goal programming.

Unit – 4	**Number of lectures = 15**	**Title of the unit: Quadratic Programming**

Quadratic programming: Wolfe's algorithm, Beale's algorithm, Theil and Vande-Pannealgorithm. Duality theory of quadratic and convex programming.

12. Brief Description of self learning / E-learning component

https://www.youtube.com/watch?v=liFWi2zR0MA&index=2&list=PLqGm0yRYwTipntZ17qTnGYAkyOPuhNEf

13. Books Recommended

1. Murty, Katta G, Linear and Combinatorial Programming
2. G. Hardy, Linear Programming, Narosa Publishing house, 1995.
3. G. Hardy, Nonlinear and Dynamic Programming, Addison-Wesley, Reading Mass.
4. H.A. Taha, Operations Research: An introduction, Macmillan Publishing Co., New York
5. N. S. Kambo, Mathematical Programming Techniques, Affiliated East-West Press.
6. O. L. Mangasarian, Non linear Programming, McGraw Hill, New York.

1. Name of the Department: Mathematics						
2. Course Name	Stochastic Process &its Applications	**L**	**T**		**P**	
3. Course Code	17070405	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 50	**Tutorials = 0**	**Practical = 0**

8. Course Description:

This course prepares students to a rigorous study of Stochastic Processes. Towards this goal, we cover elements of stochastic process and emphasizing the applications to stochastic processes. Main topics are introduction to stochastic processes, examples such as Markov chains, Poison Process, birth and death process and Applications of stochastic processes in queuing & reliability

9. Course Objectives:

1. Learn stochastic process and its large variety from introduction to an intermediate level of application knowledge.
2. Learn the stochastic processes in queues and understand different queue models.
3. Understand stochastic processes on depth and find avenues for further research.

10. Course Outcomes (COs):

The students will be able to:

1. Apply Markovian model stochastic processes and obtain solutions especially in the field of engineering
2. Derive new queue models to provide better solutions.
3. Find solutions for the untoward happening using the knowledge on reliability theory.
4. Indulge in strong research to get solutions in all walks of life since everything is probabilistic.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Stochastic Process & Markov Chains**

Stochastic Processes: definition, classification and examples. Markov Chains: definition and examples, Transition probability matrix (P), order of a Markov chain, classification of states, Stationary distribution

Unit - 2	**Number of lectures = 10**	**Title of the unit: Markov Process**

Poisson Process: Introduction, postulates, properties and related distributions, Simple birth-process, Simple death-process, Simple birth-death process.

Unit - 3	**Number of lectures = 15**	**Title of the unit: Stochastic Processes in Queuing**

Queuing models, birth and death processes in queuing theory, Markovian queuing models, Non-Markovian queuing models

Unit - 4	**Number of lectures = 15**	**Title of the unit: Stochastic Processes in Reliability**

Reliability, systems with components in series, systems with parallel components, k-out-of-n systems, Non-series parallel systems, systems with mixed mode failures, Standby redundancy: Simple standby system, k-out-of-n standby system.

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12. Brief Description of self learning / E-learning component

http://nptel.ac.in/courses/111102014/

https://onlinecourses.nptel.ac.in/noc18_ma06/preview

https://www.youtube.com/watch?v=KUDhXlnr-gU

https://www.youtube.com/watch?v=FWe5uk5NA5I

13. Books Recommended:

1. J. Medhi, Stochastic Processes, New Age International Publishers, 2009
2. Bailey, Norman T. (1965): The Elements of Stochastic Processes, John Wiley & Sons, Inc., New York.
3. E. Balagurusami, Reliability Engineering, Tata McGraw Hill, New Delhi, 1984.
4. L. S. Srinath, Reliability Engineering, Affiliated East West Press, New Delhi, 1991.

1. Name of the Department: Mathematics						
2. Course Name	Artificial Intelligence with deep learning	**L**	**T**		**P**	
3. Course Code	17070406	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 50		**Tutorials = 0**		**Practical =0**		

8. Course Description:

Machine learning is an all-encompassing discipline that tries to build cognitive capabilities through hardware-software system. Artificial intelligence is a subset of machine learning that deal with network computing that is inspired by how human brain works and tries to build a model of the things we want to predict on or find patterns in. At the heart of it, it is about analysis of data with statistical modelling with numerical and analytical reasonings, optimization based on calculus and linear algebra and non-linear processing and finding efficient deployment on suitable hardware.

This course would start with an introduction to Python programming, linear algebra, calculus and optimization theory, statistical theory and mathematical model, with hands-on practical works in the lab.

Then the course would discuss the theory of artificial neural network and its architectures - multi-layer perceptron, convolution neural network. Applications in image processing, natural language processing and data analytics in general would be emphasized.

Currently available frameworks in the field like Keras, Tensforflow, etc would be discussed.

This course has both theory and development of computer programs that apply the theory.

Formative assessment would focus on home assignments and lab based classes so that there is emphasis on development of applications.

9. Course Objectives:

The world is moving in the direction of smart software and machine and use of AI is widespread. The course would build the foundation of AI by way of emphasizing the most successful paradigm of Ai known as deep learning. The students after completing this course should be able to take up useful projects in AI on their own and most advanced students would be able to take up entrepreneurial activity. There would be an advanced version to be offered as a separate course in subsequent semester and that would focus on more advanced modeling and hands-on development and would be a mixture of project based work and standard lecture.

10. Course Outcomes (COs):

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The students after completing this course should be able to take up useful projects in AI on their own and most advanced students would be able to take up entrepreneurial activity. The students would be familiar with latest frameworks and approaches used for development of AI and would be better prepared for industry and research positions

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit: Introduction of Python Programming and Numerical Computational, Basic Machine learning**

Object-oriented and Procedural Programming with Python Machine Learning Basics - Learning Algorithms Capacity, Overfitting and Underfitti Hyperparameters and ValidationSets Estimators, Bias and Varianc MaximumLikelihoodEstimation Bayesian Statistics Supervised Learning Algorithms Unsupervised Learning AlgorithmStochastic Gradient Descent Building a Machine Learning Algorithm Challenges Motivating Deep Learning Feedforward Network - Backpropagation, Gradient based learning, hidden unit Regularization for Deep Learning - context and techniques First and Second Order Optimization Techniques Regularization Techniques

Unit – 2	**Number of lectures = 10**	**Title of the unit: Convolutional Neural Network and application in image processing**

The Convolution Operation Motivation Pooling Convolution and Pooling as an Infinitely Strong Prior Variants of the Basic Convolution Function Structured Outputs Data Types Efficient Convolution Algorithms Random or Unsupervised FeaturesThe Neuroscientific Basis for Convolutional Networks Convolutional Networks and the History of Deep Learning Application in Computer Vision (Image Processing)

Unit – 3	**Number of lectures = 15**	**Title of the unit: Recurrent and Recursive Nets**

Unfolding Computational Graph, Recurrent Neural Networks (RNNs), Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks, The Challenge of Long-Term Dependencies, Leaky Units and Other Strategies for Multiple Time Scales, The Long Short-Term Memory and Other Gated RNNs, Optimization for Long-Term Dependencies, Explicit Memory

Unit – 4	**Number of lectures = 10**	**Title of the unit: Application**

Natural Language Processing Speech RecognitionComputer VisionTransfer Learning Technique and Application

12. Brief Description of self-learning / E-learning component

- Many modules may be studied on youtube — some good ones are by **Dr Hugo Larochelle**. Coursera is another good source.

13. Books Recommended

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1. Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville, Publisher: MIT Press (3 January 2017), ISBN-10: 0262035618

2. Deep Learning with Keras, Implement Neural Network with Keras on Theano and Tensorflow, Antonio Gulli Sujit Pal, Packt Publishing

1. Name of the Department: Mathematics							
2. Course Name	Graph Theory	**L**	**T**		**P**		
3. Course Code	17070407	4	0		0		
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC (✓)**	**SEC ()**	**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical							
Lectures = 50		**Tutorials = 0**		**Practical = 0**			

8. Course Description:

This course covers basic concepts of Graph theory: meaning and different types of graphs. This course also covers the concepts of Trees, spanning tree, Circuits and Directed Graphs etc.

9. Course Objectives:

The objective of this course is to present the basic concepts of Graph Theory: Graphs, Types of graphs, Eulerian and Hamiltonian graphs, directed Graphs, Tress, Circuits, Planar Graphs, Graph Coloring etc.

10. Course Outcomes (Cos):

1. Students in this course will be able to understand the meaning and types of Graphs.
2. Students in this course will be able to work with Trees.
3. Students in this course will Demonstrate ability to work with Planar graphs and Coloring of Graphs
4. Students in this course will demonstrate ability to work with Directed graphs.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit: Introduction to Graphs**

Introduction to Graphs: Definition of a graph, finite and infinite graphs, incidence of vertices and edges, types of graphs, subgraphs, walks, trails, paths, cycles, connectivity, components of a graph, Eulerian and Hamiltonian graphs, travelling salesman problem, vertex and edge connectivity, matrix representation of graphs, incidence and adjacency matrices of graphs.

Unit – 2	**Number of lectures = 15**	**Title of the unit: Trees and Fundamental Circuits**

Trees and Fundamental Circuits: Definition and properties of trees, rooted and binary trees, counting trees, spanning trees, weighted graphs, minimum spanning tree, Kruskal Algorithm, Prim Algorithm, Decision Trees, Sorting Methods. fundamental circuit, cut set, separability, network flows.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Planar Graphs and Graph coloring:**

Planar Graphs and Graph coloring: Planar graphs, Kuratowski's graphs, detection of planarity, Euler's formula for planar graphs, geometric and combinatorial duals of a planar graphs, coloring of graphs, chromatic numbers, chromatic polynomial, chromatic partitioning, Four color theorem.

Unit – 4	**Number of lectures = 10**	**Title of the unit: Directed Graphs**

Directed Graphs: Types of digraphs, digraphs and binary relations, directed paths and connectedness, Euler digraphs.

12. Brief Description of self learning / E-learning component

https://youtu.be/RMLR2JHHeWo

https://youtu.be/q0woiOp7sqU

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https://youtu.be/fZqfkJ-cb28

13. Books Recommended:

1. NarsinghDeo, Graph Theory with Applications to Engineering and Computer Science, Prentice –Hall of India Pvt. Ltd, 2004.
2. F. Harary: Graph Theory, Addition Wesley, 1969.
3. Seymour Lipschutz and Marc Lipson, Theory and Problems of Discrete Mathematics, Schaum Outline Series, McGraw-Hill Book Co, New York, 2007.
4. John A. Dossey, Otto, Spence and Vanden K. Eynden, Discrete Mathematics, Pearson, Fifth Edition, 2005.

1. Name of the Department: Mathematics						
2. Course Name	Cryptography	**L**	**T**		**P**	
3. Course Code	17070408	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 50		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

The art of protecting information by transforming it (encrypting it) into an unreadable format, called cipher text. Only those who possess a secret key can decipher (or decrypt) the message into plain text. Cryptography is used to protect e-mail messages, credit card information, and corporate data.

9. Course Objectives:

The objectives of this course are to:

1. To understand the fundamentals of Cryptography
2. To acquire knowledge on standard algorithms used to provide confidentiality, integrity and authenticity.
3. To understand the various key distribution and management schemes.
4. To understand how to deploy encryption techniques to secure data in transit across data networks
5. To design security applications in the field of Information technology

10. Course Outcomes (COs):

At the end of the course students should be able to:

1: Analyze the vulnerabilities in any computing system and hence be able to design a security solution.

2: Identify the security issues in the network and resolve it.

3: Evaluate security mechanisms using rigorous approaches, including theoretical

4: Compare and Contrast different IEEE standards and electronic mail security

11. Unit wise detailed content

Unit-1	**Number of lectures = 18**	**Secure Communications and its Details**
Secure communications, Shift ciphers, Affine ciphers, Vigenere cipher key, Symmetric key, Public key, Block ciphers, One-time pads, Secure random bit generator, Linear feedback shift register sequences.		
Unit - 2	**Number of lectures = 12**	**Differential cryptanalysis and its application**
Differential cryptanalysis, Modes of DES, Attack on DES, Advanced encryption standard.		
Unit - 3	**Number of lectures = 10**	**RSA and its application**
RSA, Attacks on RSA, Diffie-Hellman key exchange, ElGamal public key cryptosystem, cryptographic hash function.		
Unit - 4	**Number of lectures = 10**	**RSA signatures and its application**
RSA signatures, ElGamal signature, Hashing and signing, Digital signature algorithm.		

12. Brief Description of self-learning / E-learning component

https://www.youtube.com/watch?v=eFiEKu8gl_w

7/1/19

https://www.youtube.com/watch?v=1plMO7ChXMU

13. Books Recommended

1. Bruce Schneier, Applied Cryptography: Protocols, Algorithms, and Source Code in C, Second E/d, John Wiley & Sons, 1996.
2. William Stallings, Cryptography and Network Security: Principles and Practice, Second Edition, Prentice Hall, 1998.
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