ACADEMIC REGULATIONS
COURSE STRUCTURE AND
DETAILED SYLLABUS

DEPARTMENT OF MATHEMATICS

For

M.Sc. Applied Mathematics
(Two Year **Full Time** Programme)

JNTUH COLLEGE OF ENGINEERING HYDERABAD
(Autonomous)
Kukatpally, Hyderabad – 500 085
2015

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
COLLEGE OF ENGINEERING HYDERABAD
(AUTONOMOUS)
Kukatpally, Hyderabad – 500 085

ACADEMIC REGULATIONS 2015
For CBCS Based M.Sc (Regular/Full Time) Program
(Effective for the students admitted into I year from the
Academic Year 2015**-16** and onwards)

1.0 Post-Graduate Degree Program in M.Sc (PGP in M.Sc):

JNTUH offers 2 Year (4 Semesters) full-time **Master of Science** (M.Sc) Degree Programs, under Choice Based Credit System (CBCS) at its Constituent Autonomous College - JNTUH College of Engineering Hyderabad with effect from the Academic Year 2015 - 16 onwards.

2.0 Eligibility for Admission:

2.1 Admissions to the PGPs shall be made subject to the eligibility, qualifications and specializations prescribed by JNTUH College of Engineering Hyderabad, JNT University Hyderabad, for each Specialization under each M.Sc. Program, from time to time.

2.2 Admission to the PGP shall be made either on the basis of an Entrance Test conducted by the Jawaharlal Nehru Technological University Hyderabad / on the basis of any other order of merit approved by the University, subject to reservations as prescribed by the Government from time to time.

2.3 The medium of instructions for all PG Programmes will be ENGLISH only.

3.0 M.Sc Program Structure:

3.1 The M.Sc Program in Physics, Chemistry and Mathematics of JNTUH-CEH are of Semester Pattern, with 4 Semesters constituting 2 Academic Years, each Academic Year having TWO Semesters (First/Odd and Second/Even Semesters). Each Semester shall be of 22 Weeks duration (inclusive of Examinations), with a minimum of 90 Instructional Days per Semester.

3.2 UGC/ AICTE specified Definitions/ Descriptions are adopted appropriately for various terms and abbreviations used in these PGP - Academic Regulations.

3.2.1 **Semester Scheme:**

Each Semester having - 'Continuous Internal Evaluation (CIE)' and 'Semester End Examination (SEE)'. Choice Based Credit System (CBCS) and Credit Based Semester System (CBSS) as denoted are taken as 'references' for the present set of Regulations. The terms 'SUBJECT' or 'COURSE' imply the same meaning here, and refer to 'Theory Subject', or 'Lab Course', or 'Design/ Drawing Subject', or 'Seminar', or 'Comprehensive Viva', or 'Project', as the case may be.

3.2.2 **Credit Courses:**
All Subjects (or Courses) are to be registered by a student in a Semester to earn Credits. Credits shall be assigned to each Subject/ Course in a L: T: P: C (Lecture Periods: Tutorial Periods: Practicals Periods : Credits) Structure, based on the following general pattern.

3.2.3 **Course Nomenclature:**
The curriculum nomenclature or Course structure grouping for M.Sc Degree Program is as listed below

Each subject is assigned certain number of credits as specified below.

Theory Subjects	4 Periods / Week	3 or 4 Credits
Practical subjects	6 Periods / Week	2 Credits
Practical subjects	8 Periods / Week	3 Credits
Seminar	2 Periods / Week	1 Credit
Project		3 or 4 Credits

(Each period will be of 50 minutes duration)

4.0 Course Work:

4.1 A Student, after securing admission, shall pursue and complete the M.Sc PGP in a minimum period of 2 Academic Years (4 Semesters), and within a maximum period of 4 Academic Years (starting from the Date of Commencement of I Year).

4.2 Each student shall Register for and Secure the specified number of Credits required for the completion of the PGP and Award of the M.Sc Degree in respective Branch with the chosen Specialization.

4.3 I Year is structured to provide typically 22 Credits (22 C) in each of the I , II and III Semesters, and IV Semester comprises of 24 Credits (24 C), totaling to 90 Credits (90 C) for the entire M.Sc Program.

5.0 Course Registration:

5.1 A 'Faculty Advisor' shall be assigned to each M.Sc Program with respective Specialization, who will advise the Students about the M.Sc Program Specialization, its Course Structure and Curriculum, Choice/ Option for Subjects/ Courses, based on his competence, progress, pre-requisites and interest.

6.0 Attendance Requirements:

6.1 A Student shall be eligible to appear for the End Semester Examination (SEE) of any Subject, if he acquires a minimum of 75% of attendance in that Subject for that Semester.

6.2 A Student's Seminar Report and Seminar Presentation shall be eligible for evaluation, only if he ensures a minimum of 75% of his attendance in Seminar Presentation Classes during that Semester.

6.3 Condoning of shortage of attendance up to 10% (65% and above, and below 75%) in each Subject or Seminar of a Semester may be granted by the College Academic Council on genuine and valid grounds, based on the Student's representation with supporting evidence.

6.4 A stipulated fee per Subject/Seminar shall be payable towards condoning of shortage of attendance.

6.5 Shortage of Attendance below 65% in any Subject/Seminar shall in NO case be condoned.

6.6 A Student, whose shortage of attendance is not condoned in any Subject(s) or Seminar in any Semester, is considered as 'Detained in that Subject(s)/ Seminar', and is not eligible to take End Examination(s) of such Subject(s) (and in case of Seminars, his Seminar Report or Presentation are not eligible for evaluation) in that Semester; and he has to seek Re-registration for those Subject(s)/Seminar in subsequent Semesters, and attend the same as and when offered.

7.0 Academic Requirements:

The following Academic Requirements have to be satisfied, in addition to the Attendance Requirements mentioned in Item No. 6**.**

7.1 A Student shall be deemed to have satisfied the Academic Requirements and earned the Credits allotted to each Subject/ Course, if he secures not less than 40% Marks (28 out of 70 Marks) in the End Semester Examination, and a minimum of 50% of Marks in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together; in terms of Letter Grades, this implies securing B Grade or above in that Subject.

7.2 A Student shall be deemed to have satisfied the Academic Requirements and earned the Credits allotted to - Seminar, and Comprehensive Viva-voce, if he secures not less than 50% of the total Marks to be awarded for each. The Student would be treated as failed, if he - (i) does not attend the Comprehensive Viva-voce as per the schedule given, or (ii) does not present the Seminar as required, or (ii) secures less than 50% of Marks (< 50 Marks) in -Seminar/ Comprehensive Viva-voce evaluations.
She/ he may reappear for comprehensive viva where it is scheduled again; For seminar, he has to reappear in the next subsequent Semesters, as and when scheduled.

7.3 A Student shall - register for all Subjects covering 90 Credits as specified and listed in the Course Structure for the chosen PGP Specialization, put up all the Attendance and Academic requirements for securing 90 Credits obtaining a minimum of B Grade or above in each Subject, and 'earn all 90 Credits securing SGPA ≥ 5.0 (in each Semester) and final CGPA (ie., CGPA at the end of PGP) ≥ 5.0, to successfully complete the PGP.

7.4 Marks and Letter Grades obtained in all those Subjects covering the above specified 90 Credits alone shall be considered for the calculation of final CGPA, which shall be indicated in the Grade Card of II Year II Semester.

7.5 Students who fail to earn 90 Credits as per the specified Course Structure, and as indicated above, within 4 Academic Years from the Date of Commencement of their I Year, shall forfeit their seats in M.Sc Program and their admissions shall stand cancelled.

7.6 When a Student is detained due to shortage of attendance in any Subject(s)/Seminar in any Semester, no Grade Allotment will be done for such Subject(s)/Seminar, and SGPA/ CGPA calculations of that Semester will not include the performance evaluations of such Subject(s)/Seminar in which he got detained. However, he becomes eligible for re-registration of such Subject(s)/Seminar (in which he got detained) in the subsequent Semester(s), as and when next offered, with the Academic Regulations of the Batch into which he gets readmitted, by paying the stipulated fees per Subject. In all these re-registration cases, the Student shall have to secure a fresh set of Internal Marks (CIE) and End Semester Examination Marks (SEE) for performance evaluation in such Subject(s), and subsequent SGPA/ CGPA calculations.

7.7 A Student eligible to appear in the End Semester Examination in any Subject, but absent at it or failed (failing to secure B Grade or above), may reappear for that Subject at the supplementary examination as and when conducted. In such cases, his Internal Marks (CIE) assessed earlier for that Subject/ Course will be carried over, and added to the marks to be obtained in the supplementary examination, for evaluating his performance in that Subject.

8.0 Evaluation - Distribution and Weightage of Marks:

8.1 The performance of a Student in each Semester shall be evaluated Subject-wise (irrespective of Credits assigned) with a maximum of 100 Marks for Theory, Practicals and 50 marks for Seminar.

8.2 a) For Theory Subjects, CIE Marks shall comprise of - Mid-Term Examination Marks (for 25 Marks), and Assignment Marks (for 5 Marks) for total of 30 marks.
b) During the Semester, there shall be 2 Mid-Term examinations. Each Mid-Term examination shall be for 25 Marks (with 120 minutes duration). The better performance out of these two Mid-Term Examinations shall be considered for the award of 25 Marks.

8.3 For Practical Subjects, there shall be a Continuous Internal Evaluation (CIE) during the Semester for 30 Internal Marks, and 70 Marks are assigned for Lab./Practicals End Semester Examination (SEE). Out of the 30 Marks for Internals, day-to-day work assessment in the laboratory shall be evaluated for 20 Marks; and the performance in an internal Lab./Practical Test shall be evaluated for 10 marks. The SEE for Lab./ Practicals shall be conducted at the end of the Semester by the concerned Lab. Teacher and another faculty member of the same Department as assigned by the Head of the Department.

8.4 There shall be a Seminar Presentation in I Semester II Semester and III Semester. For the Seminar, the Student shall collect the information on a specialized topic, and submit to the Department which shall be evaluated by a Departmental committee consisting of the Head of the Department and two faculty members both appointed by HOD at the time of Seminar Presentation. The Seminar Presentation shall be evaluated for 50 Marks. There shall be no SEE or External Examination for Seminar.

8.5 a) Every PGP Student shall be required to execute his M.Sc Project, under the guidance of the Supervisor assigned to him by the Head of Department. The PGP Project shall start immediately after the completion of the II Year I Semester, and shall continue through II Year II Semester. The Student shall carry out the literature survey, select an appropriate topic and submit a Project Proposal within 2 weeks (immediately after his II Year I Semester End Examinations), for approval by the Project Review Committee (PRC). The PRC shall be constituted by the Head of Department, and shall consist of the Head of Department, Project Supervisor, and a Senior Faculty Member of the Department both appointed by HOD. The Student shall submit his/ her Project Work Proposal to the PRC, on whose approval he can 'REGISTER for the PG Project'. Every Student must compulsorily register for his M.Sc Project Work, within the 2 weeks of time-frame as specified above. After Registration, the Student shall carry out his work, and continually submit 'a fortnightly progress report' to his Supervisor throughout the Project period. The PRC will monitor the progress of the Project Work Presentation and submission of M.Sc Project Work Report/ Dissertation.

b) The PRC shall evaluate the entire performance of the Student and declare the Project Report as 'Satisfactory' or 'Unsatisfactory'.

8.6 a) In cases, where the Board declared the Project Work Performance as 'unsatisfactory', the Student is deemed to have failed in the Project Viva-voce Examination, and he has to reappear for the Viva-voce Examination as per the Board recommendations. If he fails in the second Viva-voce Examination also, he will not be considered eligible for the Award of the Degree, unless he is asked to revise and resubmit his Project Work by the Board within a specified time period.

9.0 Re-Admission / Re-Registration:

9.1 **Re-Admission for Discontinued Students:**

Students, who have discontinued the M.Sc Degree Program due to any reasons what so ever, may be considered for 'Readmission' into the same Degree Program (with same specialization) with the Academic Regulations of the Batch into which he gets readmitted, with prior permission from the concerned authorities, subject to Item 4.1.

9.2 Re-Registration for Detained Students:

When any Student is detained in a Subject (s)/ Seminar due to shortage of attendance in any Semester, he may be permitted to re-register for the same Subject in the 'same category' (Core or Elective Group) or equivalent Subject if the same Subject is not available, as suggested by the Board of Studies of that

Department, as when offered in the sub-sequent Semester(s), with the Academic Regulations of the Batch into which he seeks re-registration , with prior permission from the concerned authorities, subject to Item 4.1.

10.0 Grading Procedure:

10.1 Marks will be awarded to indicate the performance of each student in each Theory Subject, or Lab/Practicals, or Seminar, or Project, etc., based on the % marks obtained in CIE + SEE (Continuous Internal Evaluation + Semester End Examination, both taken together) as specified in Item 6 above, and a corresponding Letter Grade shall be given.

10.2 As a measure of the student's performance, a 10-point Absolute Grading System using the following Letter Grades (UGC Guidelines) and corresponding percentage of marks shall be followed:

% of Marks Secured (Class Intervals)	*Letter Grade (UGC Guidelines)*	*Grade Points*
80% and above (≥ 80% , ≤ 100%)	O (Outstanding)	10
Below 80% but not less than 70% (≥ 70% , < 80%)	A^+ (Excellent)	9
Below 70% but not less than 60% (≥ 60% , < 70%)	A (Very Good)	8
Below 60% but not less than 55% (≥ 55% , < 60%)	B^+ (Good)	7
Below 55% but not less than 50% (≥ 50% , < 55%)	B (above Average)	6
Below 50% (< 50%)	F (FAIL)	0
Absent	**Ab**	**0**

10.3 A student obtaining F Grade in any Subject shall be considered 'failed' and is be required to reappear as 'Supplementary Candidate' in the Semester End Examination (SEE), as and when offered. In such cases, his Internal Marks (CIE Marks) in those Subjects will remain the same as those he obtained earlier.

10.4 A Letter Grade does not imply any specific % of Marks.

10.5 A student earns Grade Point (GP) in each Subject/ Course, on the basis of the Letter Grade obtained by him in that Subject/ Course (excluding Mandatory non-credit Courses). Then the corresponding 'Credit Points' (CP) are computed by multiplying the Grade Point with Credits for that particular Subject/ Course.

Credit Points (CP) = Grade Point (GP) x Credits …. For a Course

10.6 The Semester Grade Point Average (SGPA) is calculated by dividing the Sum of Credit Points (ΣCP) secured from ALL Subjects/ Courses registered in a Semester, by the Total Number of Credits registered during that Semester. SGPA is rounded off to TWO Decimal Places. SGPA is thus computed as

SGPA = { $\sum_{i=1}^{N} C_i G_i$ } / { $\sum_{i=1}^{N} C_i$ } …. For each Semester,

where 'i' is the Subject indicator index (takes into account all Subjects in a Semester), 'N' is the no. of Subjects 'REGISTERED' for the Semester (as specifically required and listed under the Course Structure of the parent Department), C_i is the no. of Credits allotted to the i^{th} Subject, and G_i represents the Grade Points (GP) corresponding to the Letter Grade awarded for that i^{th} Subject.

10.7 The Cumulative Grade Point Average (CGPA) is a measure of the overall cumulative performance of a student over all Semesters considered for registration. The CGPA is the ratio of the Total Credit Points secured by a student in ALL registered Courses in ALL Semesters, and the Total Number of Credits registered in ALL the Semesters. CGPA is rounded off to TWO Decimal Places. CGPA is thus computed from the I Year first semester onwards, at the end of each Semester, as per the formula

CGPA = { $\sum_{j=1}^{M} C_j G_j$ } / { $\sum_{j=1}^{M} C_j$ } … for all S Semesters registered (ie., upto and inclusive of S Semesters, S ≥ 1),

where 'M' is the TOTAL no. of Subjects (as specifically required and listed under the Course Structure of the parent Department) the Student has 'REGISTERED' from the 1st Semester onwards upto and inclusive of the Semester S (obviously M > N), 'j' is the Subject indicator index (takes into account all Subjects from 1 to S Semesters), C_j is the no. of Credits allotted to the j^{th} Subject, and G_j represents the Grade Points (GP) corresponding to the Letter Grade awarded for that j^{th} Subject. After registration and completion of I Year I Semester however, the SGPA of that Semester itself may be taken as the CGPA, as there are no cumulative effects.

10.8 For Merit Ranking or Comparison Purposes or any other listing, ONLY the 'ROUNDED OFF' values of the CGPAs will be used.

10.9 For Calculations listed in Item 10.5 – 10.8, performance in failed Subjects/ Courses (securing F Grade) will also be taken into account, and the Credits of such Subjects/ Courses will also be included in the multiplications and summations. However, Mandatory Courses will not be taken into consideration.

10.10 **Passing Standards :**

10.10.1 A student shall be declared successful or 'passed' in a Semester, only when he gets a SGPA ≥ 5.00 (at the end of that particular Semester); and a student shall be declared successful or 'passed' in the entire PGP, only when gets a CGPA ≥ 5.00; subject to the condition that he secures a GP ≥ 6 (B Grade or above) in every registered Subject/ Course in each Semester (during the entire PGP) for the Degree Award, as required.

10.10.2 After the completion of each Semester, a Grade Card or Grade Sheet (or Transcript) shall be issued to all the Registered Students of that Semester, indicating the Letter Grades and Credits earned. It will show the details of the Courses Registered (Course Code, Title, No. of Credits, Grade Earned etc.), Credits earned, SGPA, and CGPA.

11.0 Declaration of Results:

11.1 Computation of SGPA and CGPA are done using the procedure listed in 10.5 – 10.8.

11.2 For Final % of Marks equivalent to the computed CGPA, the following formula may be used ..

% of Marks = (CGPA – 0.5) x 10

12.0 Award of Degree and Class:

12.1 A Student who registers for all the specified Subjects/ Courses as listed in the Course Structure, satisfies all the Course Requirements, and passes the examinations prescribed in the entire PG Programme (PGP), and secures the required number of **90** Credits (with GP ≥ 6.0), shall be declared to have 'QUALIFIED' for the award of the M.Sc Degree in the chosen specialization as he/ she admitted.

12.2 **Award of Class**

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of M. Tech. Degree, he shall be placed in one of the following four classes based on the % CGPA:

Class Awarded	CGPA
First Class with Distinction	≥ 7.75
First Class	6.75 ≤ CGPA < 7.75
Second Class	6.0 ≤ CGPA < 6.75

12.3 A student with final CGPA (at the end of the PGP) < 6.00 will not be eligible for the Award of Degree.

13.0 Withholding of Results:

13.1 If a Student has not paid fees to University/ College at any stage, or has pending dues against his name due to any reason whatsoever, or if any case of indiscipline is pending against him, the result of the Student may be withheld, and he will not be allowed to go into the next higher Semester. The Award or issue of the Degree may also be withheld in such cases.

14.0 Transitory Regulations:

14.1 A Student - who has discontinued for any reason, or who has been detained for want of attendance as specified, or who has failed after having undergone PGP, may be considered eligible for readmission to the same PGP with same set of Subjects/ Courses (or equivalent Subjects/ Courses as the case may be), and same Professional Electives (or from same set/category of Electives or equivalents as suggested), as and when they are offered (within the time-frame of 4 years from the Date of Commencement of his I Year I Semester).

15.0 Student Transfers:

15.1 There shall be no Branch/ Specialization transfers after the completion of Admission Process.

15.2 There shall be no transfer among the Constituent Colleges and Units of Jawaharlal Nehru Technological University Hyderabad.

16. MALPRACTICES RULES:

	Nature of Malpractices	Punishment
	If the candidate:	
1 (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
1 (b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The Hall Ticket of the candidate is to be cancelled.
3	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.

4	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.
6	Refuses to obey the orders of the Chief Superintendent / Assistant – Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.
7	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining

		examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.
9	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a 8police case will be registered against them.
10	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester / year examinations.
12	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the College / University for further action to award suitable punishment.	

17. GENERAL:

- **Credit**: A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week.
- **Credit Point:** It is the product of grade point and number of credits for a course.
- The Academic Regulations should be read as a whole for the purpose of any interpretation.
- The University/College reserves the right of altering the Academic Regulations and/or Syllabus/Course Structure, as and when necessary. The modifications or amendments may be applicable to all the candidates on rolls, as specified by the University/College.
- Wherever the words 'he' or 'him' or 'his' occur in the above regulations, they will also include 'she' or 'her' or 'hers'.
- Wherever the word 'Subject' occurs in the above regulations, it implies the 'Theory Subject', 'Practical Subject' or 'Lab.' and 'Seminar'.
- In case of any ambiguity or doubt in the interpretations of the above regulations, the decision of the Vice-Chancellor will be final.

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JNTUH COLLEGE OF ENGINEERING HYDERABAD
(Autonomous)

M.Sc. (Applied Mathematics) – Full Time w.e.f. 2015-16

I YEAR **I SEMESTER**

S.No.	Code	Subject	L	P	Credits
1	APM05101	Analysis- I	4	0	4
2	APM05102	Algebra	4	0	4
3	APM05103	Theory of Ordinary Differential Equations	4	0	4
4	APM05104	Numerical Analysis	4	0	4
5	APM05105(i) APM05105(ii) APM05105(iii)	**Departmental Elective-I** (One of the following is to be selected) i) Calculus of variations ii) Mechanics iii) Differential Geometry	4	0	3
6	APM05106	'C' Programming Lab	2	6	2
7	APM05107	Seminar			1
		Total			**22**

I YEAR **II SEMESTER**

S.No.	Code	Subject	L	P	Credits
1	APM05201	Analysis- II	4	0	4
2	APM05202	Linear Algebra	4	0	4
3	APM05203	Complex Analysis	4	0	4
4	APM05204	Integral Transforms and Integral Equations	4	0	4
5	APM05205(i) APM05205(ii) APM05205(iii)	**Departmental Elective-II** (One of the following is to be selected) i) Discrete Mathematics ii) Advanced Differential Equations iii) Galois Theory	4	0	3
6	APM05206	Data Structures through 'C'	2	6	2
7	APM05207	Seminar			1
		Total			**22**

JNTUH COLLEGE OF ENGINEERING HYDERABAD
(Autonomous)

M.Sc. (Applied Mathematics) – Full Time w.e.f. 2015-16

II YEAR **I SEMESTER**

S.No	Code	Subject	L	P	Credits
1	APM05301	Topology	4	0	4
2	APM05302	Probability and Statistics	4	0	4
3	APM05303	Partial Differential Equations	4	0	4
4	APM05304	Optimization Techniques	4	0	4
5	APM05305(i) APM05305(ii) APM05305(iii)	**Departmental Elective-III** (One of the following is to be selected) i) Discrete Time Control Systems. ii) Differential Equations and Dynamical Systems iii) Artificial Neural Networks	4	0	3
6	APM05306	MATLAB-I	2	6	2
7	APM05307	Seminar			1
		Total			**22**

II YEAR **II-SEMESTER**

S.No	Code	Subject	L	P	Credits
1	APM05401	Functional Analysis	4	0	4
2	APM05402	Operation research	4	0	4
3	APM05403	Theory of Computation	4	0	4
4	APM05404	Analytic Number Theory	4	0	4
5	APM05405(i) APM05405(ii) APM05405(iii)	**Departmental Elective-IV** (One of the following is to be selected) i) Measure and Integration ii) Dynamic Models and Control of Biological Systems iii) Fluid Mechanics	4	0	3
6	APM05406	MAT LAB-II	2	6	2
7	APM05407	Project	-	8	3
		Total			**24**

JNTUH COLLEGE OF ENGINEERING HYDERABAD

M.Sc. I Year I-Sem (Applied Mathematics)

L	T	P	C
4	0	0	4

101- ANALYSIS- I

Pre Requisites: No Pre Requisites. Foundation Course.

Objectives:

- To train the students thoroughly in mathematical concepts of Basic analysis.
- To impart firm foundation in analysis which is useful in many other subjects of mathematics

UNIT-I

Basic Topology: Finite -Countable and Uncountable sets- (Definitions and Statements only without proof)-Metric Spaces- Compact Sets- Perfect Sets- Connected Sets- Numerical **Sequences and Series**: Convergent Sequence- Subsequences- Cauchy Sequences- Upper and Lower limits- Some Special Sequences.

UNIT-II

Infinite Series: Series of Non-negative Terms- The Number *e*- The Root and Ratio Tests- Power Series- Summation by parts- Absolute Convergence- Additional and Multiplication of Series.

UNIT-III

Continuity: Limits of Functions- Continuous Functions- Continuity and Compactness- Continuity and Connectedness- Discontinuities- Monotonic Functions- Infinite limits and Limits at infinity.

UNIT-IV

Differentiation: The Derivative of a real function- Mean value theorems- The Continuity of Derivatives- L'Hosoital's Rule- Derivatives of Higher Order- Taylor's Theorem- Differentiation of vector –Valued functions.

UNIT-V

The Riemann-Stieltjes Integral-Definition and Existence of the Integral- Properties of Integral- Integration and Differentiation

Scope as in:

1. Principles of Mathematical Analysis- Walter Rudin, Third Edition, Mc Graw Hill.

References:

1. Introduction to Real Analysis- R.G. Bartle and D.R. Sherbert, third Edition, Jonh Wiley.
2. Mathematical Analysis- Tom. M. Apostol, Narosa Punblishing House.
3. A First Course in Real Analysis- S.K. Berberian, Springer.
4. Basic Real Analysis– Houshang H. Sohrab, Springer International Edition.
5. Elementary Analysis, The Theory of Calculus- Kenneth A. Ross, Springer.

Outcomes:

- The students become familiar with basic concepts of analysis.
- The students attain the ability to use this knowledge to understand and to solve many problems on other subjects like Differential Equations, Partial Differential equations etc.
- This is a foundation course and students can use this as a pre requisite for many other subjects in their upcoming semesters.

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M.Sc. I Year I-Sem (Applied Mathematics)

L	T	P	C
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102- ALGEBRA

Pre Requisites: No Pre Requisites. Foundation Course.

Objectives:

- To train the students thoroughly in mathematical concepts of algebra.
- To impart firm foundation in algebra which is useful in many other subjects of mathematics.

UNIT-I

Group Theory: Definition of a Group – Some examples of group – Some preliminary Lemmas – Subgroups – A counting principle – Normal subgroups and Quotient groups.

UNIT-II

Group Theory: Homomorphisms – Automorphisms – Cayley's Theorem – Permutation Group

UNIT-III

Another counting principle – Sylow's Theorem – Direct products – Finite abelian groups -

UNIT-IV

Ring Theory: Definition and examples of rings – Some special classes of rings – Homomorphisms – Ideals and quotient rings – More ideals and quotient rings – The field of quotients of an integral domain.

UNIT-V

Ring Theory: Euclidean rings – A particular Euclidean ring – Polynomial rings – Polynomials over the rational field – Polynomial rings over commutative rings.

Scope as in:

1. Basic Abstract Algebra- P.B. Bhattacharya, S.K. Jain, S.R. Nagpaul, Second Edition, Cambridge University Press.

References:

1. Topics in Algebra- I.N. Herestein, John Willey-
2. Algebra- M.Artin, PHI.
3. Algebra Contemporary Abstract- Joseph A. Gallian, Narosa.
4. Algebra- Serge Lang, Springer.
5. Basic Algebra- P.B. Cohn, Springer.

Outcomes:

- The students become familiar with basic concepts of algebra.
- The students attain the ability to use this knowledge to understand and to solve many problems on other subjects like galois theory.
- This is a foundation course and students can use this as a pre requisite for many other subjects in their upcoming semesters.

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103- THEORY OF ORDINARY DIFFERENTIAL EQUATIONS

Pre Requisites: No Pre Requisites. Foundation Course.

Objectives:

- To train the students thoroughly in mathematical concepts of Theory of Ordinary Differential Equations.
- To impart firm foundation in Theory of Ordinary Differential Equations which is useful in many other subjects of mathematics.
- To train the students to use this knowledge in mathematical modeling and some related research areas.

UNIT-I

Linear Equation with Variable Coefficients: Introduction- Initial Value Problem for the Homogeneous Equation- Solutions of the Homogeneous Equation- The Wronskian and linear independence- Reduction of the order of a Homogeneous Equation- The non-homogeneous Equation- Homogeneous Equations with analytic Coefficients- The legendre Equation- Justification of the power series method.

UNIT-II

Linear Equations with Regular Singular points: Introduction- The Euler equation- Second order equations with Regular Singular points- the general case- A convergence proof- The exponential case- The Bessel Equation- Regular Singular points at infinity.

UNIT-III

Existence and Uniqueness of solution to First order Equations: Introduction-Equations with Variables separated- Exact Equations- The Method of Successive Approximations.

UNIT-IV

The Lipschitz condition-Convergence of recursive approximations- Non-local existence of solutions- Approximation to- and uniqueness of solutions- Equation with complex valued functions.

UNIT-V

Existence and uniqueness of solutions of nth order equations: Introduction- An example- central forces and planetary motion- some special equations- Complex n-dimensional space- Systems as vector equations- Existence and uniqueness of solutions to systems- Existence and uniqueness for linear systems- Equations for order n.

Scope as in:

1. An Introduction to Ordinary Differential Equations- Earl A. Coddington, PHI.

References:

1. Differential Equation with Applications and Historical notes. –G.F.Simmons- Tata MC.GrawHill.
2. Text Book of Ordinary Differential Equations- SG. Deo, V. Lakshmikanthan, V. Ragavendra, Tata Mc.GrawHill.

3. A First Course in Differential Equations With Modeling Applications- Dennis G .Zill, 8th Edition, Thomson Books/college.
4. Elementary Differential Equations & Boundary Value Problems- Boyce-Dprima, Seventh Edition, John Willey.

Outcome:

- The students now ready to take higher courses in Differential Equations and Dynamical Systems.

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L	T	P	C
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104- NUMERICAL ANALYSIS

Pre Requisites: No Pre Requisites. Foundation Course.

Objectives:

- To give a firm foundation on numerical techniques involved in the study of higher mathematics

UNIT-I

Introduction- Computer Arithmetic-Errors- **Transcendental and Polynomial Equations**: Introduction- Bisection Method-Iteration methods based on First Degree Equation- Rate of Convergence – Iteration Methods – Methods for Complex Roots-Polynomial Equations-Choice of an Iterative Method and Implementation Problems.

UNIT-II

Introduction-Lagrange and Newton Interpolations- Finite Difference Operators- Interpolating Polynomials using finite Difference – Hermit Interpolations – Piecewise and Spline Interpolation.

UNIT-III

Bivariate Interpolation- Application-Least Squares Approximation- Rational Approximation-Choice of the Method- Problems.

UNIT-IV

Differentiation and Integration: Introduction- Numerical Differentiation- Optimum Choice of step length- Extrapolation Methods- Partial Differentiation- Numerical Integration- Methods Based on Interpolation- Methods Based on Undetermined Coefficients- Composite Integration Methods- Romberg Integration- Double Integration- Problems.

UNIT-V

Ordinary Differential Equations: Introduction- Numerical Methods- Single step Methods-Multi step Methods- Predictor-corrector Methods- Stability Analysis- Stiff System- Boundary Value Problems- Initial Value Problems- Finite Difference Methods Problems.

Scope as in:

1. Numerical Methods for Scientific and Engineering Computation- M.K. Jain, S.R.K. Iyengar, R.K.Jain, New Age International.

References:

1. Elementary Numerical Analysis-Atkinson and Hahn, John Willey.
2. An Introduction to Numerical Analysis-. Atkinson and Hahn, John Willey.
3. Introductory Methods of Numerical Analysis- S.S. Sastry, PHI.

Outcome:

- The student is able to solve all kinds of equations including algebraic, ODE, PDE, Differentiate, and Integrate using numerical techniques.

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Departmental Elective- I
105(i). CALCULUS OF VARIATIONS

Pre Requisites: No Pre Requisites. Foundation Course.

Objectives:
- To teach students variational techniques,

UNIT-I
The methods of variations in problems with Fixed Boundaries: Variation and its properties- Euler's equation- Functionals of the form $\int_{x_0}^{x_1} F(x, y_1, y_2, ...y_n, y_1', y_2', ...y_n')dx$ - Functionals dependent on Higher order derivatives.

UNIT-II
Functionals dependent on the functions of several independent variables- Variational problems in parametric form- Some applications.

UNIT-III
Variational problems with moving boundaries and certain other problems: An elementary problem with moving boundaries- The moving boundary problem for a functional of the form $\int_{x_0}^{x_1} F(x, y, z, y', z')dx$ - Extremals with corners- One sided variations.

UNIT-IV
Sufficient conditions for an Extremum: Field of extremals- The function $E(x, y, p, y')$ - Transforming the Euler equations to the canonical form.

UNIT-V
Variational problems involving a conditional extremum: Constraints of the form $\varphi(x, y_1, y_2, ..., y_n) = 0$ - Constraints of the form $\varphi(x, y_1, y_2, ..., y_n, y'_1, y'_{2,} ....., y_n) = 0$ - Iso perimetric problems.

Scope as in:
1. Differential equations and the calculus of variations- George Yankovsky- Mir Publishers.

References:
1. Methods of Applied Mathematics, 2nd Edition - Francis B. Hildebrand, PHI.
2. Calculus of variations- Gelfand, Prentice Hall, Inc.

Outcomes:
- The student can apply variational techniques to different problems in mathematics.

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L	T	P	C
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105(II). MECHANICS

Pre Requisites: No Pre Requisites. Foundation Course.

Objectives:

- To give an overview of some important concepts in applied mathematics like principles of least action, an introduction to the mathematical physics.

UNIT-I

Lagrangian formulation: Mechanics of a particle- Mechanics of a system of particles- Constraints- Generalized coordinates- Generalized velocity- Generalized force and potential- D' Alembert's principle and Lagrange's equation- Some applications of lagrangian formulation.

UNIT-II

Hamilton's principle- derivation of Lagrange's equations from Hamilton's principle- Extension of Hamilton's principle to non Homonymic systems- Advantages of variational principle formulation- conservation theorems and symmetry properties- **Hamiltonian formulation**: Legendre transformations and the Hamilton equations of motion- cyclic coordinates and conservation theorems- Derivation of Hamilton's equations from a variational principle.

UNIT-III

The principle of least action- the equation of canonical transformation- examples of canonical transformation- Poisson and Lagrange brackets and their invariance under canonical transformation- Jacobi's identity- Poisson's theorem- Equations of motion infinite estimal canonical transformation in the Poisson bracket formulation.

UNIT-IV

Hamilton Jacobi equations for Hamilton's principle function- The harmonic oscillator problems as an example of the Hamilton- Jacobi method- New concept of space and time- postulates of special theory of relativity.

UNIT-V

Lorentz transformation equation- Lorentz contraction- Time dilation- Simultaneity- Relativistic formulae for composition of velocities and accelerations- Proper time- Lorentz transformations form a group.

Scope as in:

1. Classical Mechanics, 2nd Edition- H. Goldstein, Narosa Publishing House.
2. Introduction to Theopry of Relativity- P. G. Bergman.

References:

1. Relevant topics from special relativity- W. Rindler- Oliver & Boyd, 1060.
2. An elementary treatise on the dynamics of a particle and of rigid bodies- S. L. Loney.
3. A first course in mechanics, Grant R. Fowler, PHI.
4. Continuum Mechanics- D. S. Chandrashekaraiah.

Outcome:

- The student can apply mathematical concepts to real world systems.

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L	T	P	C
4	0	0	3

105 (iii). DIFFERENTIAL GEOMETRY

Pre Requisites: No Pre Requisites. Foundation Course.

Objectives:

- To train the students thoroughly in mathematical concepts of Differential Geometry.
- To impart firm foundation in Differential Geometry which is useful in many other subjects of mathematics.
- To train the students to use this knowledge in mathematical modeling and some related research areas.

UNIT-I

Curves in the plane in space: What is Curve- Arc- Length- Reparametrization- Level Curves vs Parametrized Curves- How much does a curve curvature- Plane curves- Spaces Curves.

UNIT-II

Global Properties of Curves: Simple closed curves- The isoperimetric inequality- The four vertex Theorem- Surfaces in Three Dimensions- What is a surface in Three Dimensions- What is a Surface- Smooth Surfaces- Tangents, Normals and Orientability- Examples of Surfaces- Quadratic Surfaces- Triply Orthogonal Systems- Applications of the Inverse Function Theorem.

UNIT-III

The First Fundamental Form: Length of curves on surfaces- Isometric of Surfaces- Conformal mapping of surfaces- Surfaces area- Equiareal maps and a theorem of Archimedes- Curvature of surfaces: The second fundamental form- the curvature of curves on a surface- The normal and principle curvatures.

UNIT-IV

Gaussian Curvature and the Gauss Map: The Gaussian and mean curvatures- The pseuidphere- Flat surfaces- Surfaces of constant mean curvature- Gaussian curvature of compact surfaces- The gauss map- **Geodesics:** Definition and basic properties- Geodesic equations- Geodesics on surfaces of revolution- Geodesics as shortest paths- Geodesic coordinates.

UNIT-V

Minimal Surfaces: Plateau's problem- Examples of minimal surfaces- Gauss map of a minimal surface- Minimal surfaces and holomorpic functions- **Gauss's theorems Egregium:**Gauss's remarkable theorem- Isometrics of surfaces- the codazzi- Mainardi equations – Compact surfaces of constant Gaussian curvature.

Scope as in:

1. Elementary differential geometry- Andrew Pressley, Springer.

Reference:

1. Elementary Topics in Differential Geometry- J. A. Thrope, Springer.
2. Three Dimensional differential Geometry- Bansilal.

Outcome:

- The students now ready to take higher courses in Differential Equations and Dynamical Systems

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106- 'C' PROGRAMMING LAB

Pre Requisites: No Pre Requisites. Foundation Course.

Objectives:

- To provide students with a comprehensive study of the C programming language. Classroom lectures stress the strengths of C, which provide programmers with the means of writing efficient, maintainable, and portable code. The lectures are supplemented with non-trivial lab exercises.

UNIT-I

Theoretical concepts: Introduction to 'C' language. Basic Structure of C programming- Keywords and Identifiers- constants- variables- data types- declaration of variables- assigning values of variables- Definition symbolic constants case study.
Introduction operators and expressions - Arithmetic relational and logical operators Increment and decrement operators- control operators- expressions and evaluation of expressions- input/ output operators.
Introducing decision making: Branching and Looping Decision Making with IF-IF- ELSE- Nesting of IF.. ELSE- ELSE.IF Ladder switch statement- WHILE- DO- FOR loops.

UNIT-II

Arrays: Introduction- Array Initialization- Definition of Array- Characteristics of Array- One Dimensional Array- predefined streams- Two dimensional Array- Three or Multi-dimensional Arrays.
Strings: Declaration and Initialization of Strings-Display of Strings with Different Formats-Strings Standard Functions-Application of Strings.
Pointers: Introduction-Features of Pointer-Pointer Declaration-Arithmetic Operations with Pointers-Array of pointer-Pointers to pointers-Void Pointers.
Functions: introduction-Definition of Function-Declaration of Function and function Prototypes-The Return Statement-Types of functions-Call by value and Reference-Function Returning More Values –Function as an Argument-Function with Operators-Function and Decision statements-Function and Loop Statements- Function with Array and Pointers-Recursion-Pointer to Function.

UNIT-III

Storage classes: Introduction – Automatic Variables-External Variables-Static Variables-Register Variables- Preprocessor Directives: Introduction-The #define Directive- Undefining A Macro-Token pasting and Stringizing Operators-The # include Directive-Conditional Compilation- The #error Directive-The # line Directive- Inline Directive-The # Pragma Saveregs-The Predefined Macros in ANSI and turbo C-Standard I/O Predefined Streams in stdio.h.

UNIT- IV

Structure and Union: Introduction-Features of Structures-Declaration and Initialization of Structure-Structure with Structure-Array of Structures-Pointer to Structure- Structure and Function-Typedef-Bit Fields-Enumerated Data Type-Union-Calling BIOS and DOS Services-Union of Structures.

UNIT-V

Files: Introduction-Streams and File Types-Steps For File Operations-File I/O-Structures Read and Write-Other File Function-Searching Errors in Reading/Writing Files-low Level Disk I/O-Command Line Arguments-Application of Command Line Arguments-Environment Variables-I/O Re Direction.

Scope as in:

1. Programming in ANSI E. Balaguruswamy.
2. Programming in C, Second Edition, Pradeep Day & Monas Ghosh- Oxford University Press.

References:

1. Let Us C-.C. Proramming - - Kanitkar Schaum series.

Outcome:

Upon completion of this course, students will be able to:

- Write C programs that are non-trivial.
- Use the variety of data types appropriate to specific programming problems.
- Utilize the modular features of the language.
- Demonstrate efficiency and readability.
- Demonstrate the use of the various control flow constructs.
- Use arrays as part of the software solution.
- Utilize pointers to efficiently solve problems.
- Include the structure data type as part of the solution.
- Create their own data types.
- Use functions from the portable C library.

Lab Practice:

1. Write a program for addition of two numbers.
2. Write a program for finding area and circumference of a circle.
3. Write a program for finding simple interest.
4. Write a program for finding area and perimeter of a rectangle.
5. Write a program to read 5 subject marks of a student and find average marks of that student.
6. Write a program to convert the given KMPH to Meter per second.
7. Write a program to convert the given number of days into months and days.
8. Write a program to check whether the given number is even or odd.
9. Write a program to check whether the given number is positive or negative.
10. Write a program to calculate the division obtained by a student.
11. Write a program to demonstrate the use of sizeof() operator
12. Write a program to swap two numbers using 3 variables and 2 variables.
13. Write a program to find the biggest of three numbers.
14. Write a program to check whether the given year is leap year or not.
15. Write a program to read a date from the key board, and check whether the given date is in correct format or not. (dd/ mm/ yyyy)
16. Write a program to convert the given temperature from Fahrenheit to centigrade.
17. Write a program to count number of hundred notes, fifty notes and ten notes for the given amount.
18. Write a program to read an integer and check whether the entered value is palindrome or not.
19. Write a program to read an integer value, and print that integer in reverse order

20. Write a program to read an integer and check whether the entered value is Armstrong or not.
21. Write a program to evaluate arithmetic operations using switch case.
22. Write a program to evaluate arithmetic operations on complex numbers using switch case.
23. Write a program to determine whether the given character is vowel or not using switch case.
24. Write a program to calculate sum of all the numbers between 1 and 50 excluding multiples of 3 and 5.
25. Write a program to calculate the sum of digits of an integer.
26. Write a program to check whether the given number is prime or not.
27. Write a program to solve the following series
28. Write a program to calculate the sum of N- Terms of the following series
29. Write a program to calculate the sum of N- Terms of the following series
30. Write a program to print Fibonacci series of N terms.
31. Write a program to calculate the sum of odd numbers between 1 and 50.
32. Write a program to read a character from the keyboard and tell the user whether the character is alphabet, digit or any other special character.(use character test functions)
33. Write a program to read a character from the key board and print that character in reverse case. (use character test functions)
34. Write a program to find a large number in a given array.
35. Write a program to find the average, min and max value for the given array of elements.
36. Write a program to find Fibonacci series using arrays.
37. Write a program to read Two M X N Matrix and perform Addition Operation.
38. Write a program to read Two M X N Matrix and perform Subtraction Operation
39. Write a program to read Two M X N Matrix and perform Multiplication Operation
40. Write a program to read a M X N Matrix and find the Transpose of that matrix.
41. Write a program to read M X N and find the trace of the Matrix.
42. Write a program to read a M X N Matrix and print the diagonal elements.
43. Write a program to read a string and find the number of vowels in the given string.
44. Write a program to read a string and check whether the given string is palindrome or not.
45. Write a program to find the length of the given string including and excluding spaces.
46. S1, S2, S3 are three string variables. Write a program to read two string constants into S1 and S2 and compare whether they are equal or not. If they are not equal join them together. Copy the contents of S1 into the variable S3. At last the program should print the contents of all the three variables and their lengths.
47. Write a program to print a Fibonacci series using functions.
48. Write a program to find the factorial of a given number using recursive function.
49. Write a program to obtain prime factors of given number using functions.
50. Write a program to calculate sum of digits of an integer with and without recursion.
51. Write a program to pass a user defined function as an argument to another function.
52. Write a program to print structure elements.
53. Write a program to display the difference between structure and union.
54. Write a program to use structure within union.
55. Write a program to pass a structure variable as an argument to a user defined function.
56. Write a program to read and display car details using nested structures.
57. Write a program to print the Pascal triangle
58. Write a program to print the Parallelogram.
59. Write a program to swap two numbers using pointers.

60. Write a program to print the values and addresses of variables and pointer variables .
61. Write a program to perform different arithmetic operations using pointers.
62. Write a program to declare void pointer, assign address of integer, float and character to the pointer variable using type casting, and display the contents of the various variables.
63. Writ e a program to declare a pointer variable to a structure and display the contents of the structure.
64. Write a program to show the effect of increment operator on pointer variable. Display the memory location of integer, character and float variables before and after increment operation on pointer variables.
65. Write an example program for call by value concept.
66. Write an example program for call by reference concept.

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201- ANALYSIS-II

Pre Requisites: Analysis- I.

Objectives:

- To train the students thoroughly in mathematical concepts of advanced Mathematical analysis.
- To impart firm foundation in analysis which is useful in many other subjects of mathematics

UNIT-I

Sequences and Series of Functions: Discussion of main problem – Uniform convergence - Uniform convergence and continuity - Uniform convergence and integration - Uniform convergence and differentiation.

UNIT-II

Equicontinuous families of functions – The stone - weierstrass theorem.
Some Special Functions: Power series – The exponential and logarithmic functions – The Trigonometric functions.

UNIT-III

The algebraic completeness of the complex field – Fourier series – The gamma function

UNIT –IV

Functions of several variables: Linear transformations – Differentiation – The contraction principle – The inverse function theorem – The implicit function theorem.

UNIT-V

The rank theorem – Determinants – Derivatives of higher order – Differentiation of integrals.

Scope as in:

1. Principles of Mathematical Analysis- Walter Rudin, Third Edition, Mc Graw Hill.

References:

1. Introduction to Real Analysis- R.G. Bartle and D.R. Sherbert, third Edition, Jonh Wiley.
2. Mathematical Analysis- Tom. M. Apostol, Narosa Punblishing House.
3. Basic Multivariable Calculus- Jerrold E. Marsden, Anthony Tromba, Alan Weinstein, Springer.
4. Real Analysis- N.L. Carathors, Cambridge University Press.
5. Calculus, Tom M Apostol, Volume- 1, Jonh Wiley.
6. Calculus, Tom M Apostol, Volume- 2, Jonh Wiley.
7. Elementary Analysis, The Theory of Calculus- Kenneth A. Ross, Springer.

Outcomes:

- The students become familiar with advanced concepts of analysis.
- The students attain the ability to use this knowledge to understand and to solve many problems on other subjects like Differential Equations, Partial Differential equations etc.

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202- LINEAR ALGEBRA

Pre Requisites: Algebra

Objectives:

- To train the students thoroughly in mathematical concepts of Linear Algebra.
- To impart firm foundation in linear algebra which is useful in many other subjects of mathematics.

UNIT-I

Vector spaces Euclidean: "a" spaces– General vector spaces– Subspaces - Linear independence- Basis and dimension – Row and Column space of a Matrix- Rank Applications to finding Basis.

UNIT-II

Inner product spaces- length and angle in inner product spaces Ortho normal- basis- Gram-Schmidt process –Coordinates- change of basis.

UNIT-III

Linear Transformations : Introduction to Linear transformation –Properties of Linear transformations – Kernel and Range- Linear transformations from R to R Geometry of linear transformations from R^2 to R^2 - Matrices of Linear transformations – Similarity.

UNIT-IV

Eigen values and Eigen vectors: Eigen values and Eigen vectors – Orthogonal- Unitary-Normal and Hermitian- similar matrices- Properties of Eigen values and Eigen vectors – diagonalization. Factorization.

UNIT-V

Applications: Applications to differential relations – Application to approximation –Problem-quadratic forms- Applications to conic sections- Application to Quadratic surfaces.

Scope as in:

1. Elementary Linear Algebra– HowardAnton, 5th Edition, John Wiley and Sons.

Reference:

1. An introduction to Linear Algebra- V. Krishna Murthy, Affiliated East-West press.
2. Introduction to Matrix Analysis- Richard Bellimen, Tata Mc Graw- Hill.
3. Linear Algebra-An Inroductory Approach- William Curtis, 4th edition, springer.
4. Linear Algebra- Kenneth Hoffman and Ray Kunge, PHI.
5. Linear Algebra with Applications- Olto Bretscher, Pearson Education.

Outcomes:

- The students become familiar with advanced concepts of algebra.
- The students attain the ability to use this knowledge to understand and to solve many problems on other subjects like Galois Theory.
- This is a foundation course and students can use this as a pre requisite for many other subjects in their upcoming semesters.

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203- COMPLEX ANALYSIS

Pre Requisites: Analysis- I

Objectives:

- To train the students thoroughly in mathematical concepts of complex analysis.
- To impart firm foundation in analysis which is useful in many other subjects of mathematics

UNIT-I The complex Plane and Elementary Functions: Complex numbers- Polar representation - Stereographic Projections- The Square and Square Root Functions- The Exponential Function- The Logarithm Function- Power Functions and Phase Factors- Trigonometric and Hyperbolic Functions.

UNIT-II Analytic Functions: Analytic Functions- The Cauchy-Riemann Equations- Inverse Mapping and the Jacobian- Harmonic Functions- Conformal mappings - Fractional Linear Transformations.

UNIT-III Line Integrals and Harmonic Functions-Line Integrals and Green's theorem- Independence of path**-** Harmonic Conjugate- The Mean Value Property- The maximum Principle- **Complex Integration and Analyticity:** Complex Line Integrals- Fundamental Theorem of Calculus for Analytic Functions- Cauchy's Theorem- The Cauchy Integral Formula- Liouville's Theorem -Morera's Theorem- Gourasat's Theorem.

UNIT –IV

Power Series-Infinite Series- Sequences and Series of Functions- Power Series- Power Series Expansion of an analytic Function- Power Series Expansion at Infinity- Manipulation of Power Series- The Zeros of an Analytic Function- Analytic Continuation- **Laurent Series and Isolate Singularities:** The Laurent Decomposition- Isolated Singularities of an Analytic Function - Isolated Singularity at Infinity- Partial Fractions of Decomposition- **The Residue calculus-** The Residue Theorem- Integrals Featuring Rational Functions- Integrals of Trigonometric Functions- Integrands with Branch Points- Fractional Residues.

UNIT-V

The Argument Principle- Rouche's Theorem- Hurwitz's Theorem- Open Mapping and Inverse Function Theorems- Critical points- Winding Numbers- **Harmonic Functions and The Reflection Principle:** The Poisson Integral Formula- Characterization of Harmonic Functions- The Schwarz Reflection Principle.

Scope as in:

1. Complex Variables and Applications- J.W .Brown and R.V. Churchill, 6th Edition, Mc Graw-Hill.
2. Complex Analysis- Theodary W. Gamelin, Springer International Edition.

References:

1. Functions of One Complex Variable– John B. Conway, Springer.
2. Complex Analysis- L. Ahlfors, Mc Graw-Hill.
3. Complex Analysis- Serge Lang, springer.

Outcomes:

- The students become familiar with concepts of complex analysis.
- The students attain the ability to use this knowledge to understand and to solve many problems on other subjects like Differential Equations, Partial Differential equations etc.

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204. INTEGRAL TRANSFORMS AND INTEGRAL EQUATIONS

Pre Requisites: Analysis- I and TODE

Objectives:

- The student is trained to learn various techniques of transforms.
- To train the student in order to learn how to apply the techniques in applications.

UNIT-I Laplace Transform: Definition- The Inverse Laplace Transform- Discontinuous Functions,Heaviside's expansion formula- Operational Properties of Laplace Transforms, The convolution theorem- Delta Function, Application of Laplace Transforms,(scope as in Advanced Engineering Mathematics by Alan Jeffrey Elsevier- Form 7.1 to 7.3).

UNIT-II The Fourier Integrals and Transforms: The Fourier Integrals, Dirichlet conditions for the existence, Fourier Integral representation forms, Fourier Transform- Inverse Fourier Transform, Properties – Fourier sine and cosine Transforms –Convolution Theorem.

UNIT-III Z-transforms: Introduction- Sequence- Z-transform- Region of Convergence- Standered Z-transforms- Inverse Z-transform- Properties of Z-transform- Convolution- Double Z-transform- modified Z-transform. (Book: Mathematical Methods by Srimantha Pal- OXFORD Publications- Chapter 16 from 16.1- 16.8, 16.10, 16.11).

UNIT-IV Integral Equations: Introduction-Volterra integral equations-Relationship between IVP and Volterra integral equations- Method of iterative kernels- Method of polynomial kernel- Application of Laplace transform to Volterra Integral Equation- Integro Differential equations- Volterra integral equation of first kind- Euler's Integrals –Abel's problem-Abel's Integral Equation and generalizations- Volterra integral equation of convolution type.

UNIT-V Fredholm Integral Equations- Fredholm Integral Equation of the second kind-fundamentals-The method of fredholm determination-Integrated kernels method – Integral equation with degenerative kernel-Characteristic members and eigen functions- solution of homogeneous equation with degenerative kernels-Non homogeneous Symmetric Equation. Fredholm Alternative- Green's function.

Scope as in:

1. Operational Mathematics- R.V.Churchil.
2. Transforms-I. N Sneddon
3. Problems and Exercises in Integral Equations- M. Kraslov, A.Kiselev, Mir Publishers

Reference:

1. Operational Mathematics- R.V.Churchil.
2. Laplace Transforms- Springer.
3. Introduction to Integral equations with applications- Abdul J Jerri, Marcel, Dekker Inc
4. Methods of Applied Mathematics- Francis B.Hildebrand, Second Edition, PHI Ltd, New Delhi

Outcome:

- The student is able to solve differential equations, boundary value problems and integral equations by using various transform techniques

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L	T	P	C
4	0	0	3

205- Departmental Electives
205(I). DISCRETE MATHEMATICS

Pre Requisites: Algebra.

Objectives:

- To train the students thoroughly in mathematical concepts of discrete mathematics.
- To impart firm foundation in discrete mathematics which is useful in many other subjects of mathematics.
- The student is made to learn the logic and the applications into computer science.

UNIT-I

Recurrence Relations: Generating Functions-Coefficients of Generating Functions-Recurrence Relations-Inhomogeneous recurrence relations.

UNIT-II

Relations and Digraphs: Product Sets and Partitions- Relations and Digraphs- Paths in relation and Digraphs- Properties of Relations- Equivalence Relations -Data structures for Relations and Digraphs- Operations on Relations- Transitive Closure and Warshall's Algorithm- Adjacency Matrices.

UNIT-III

Functions: Functions- Functions for Computer Science- Growth of Functions- Permutation Functions.

UNIT-IV

Order Relations and Structure:-Partially Order Sets- External Elements of Partially Ordered Sets- Lattices- Finite Boolean Algebras- Functions on Boolean Algebras- Circuit Design.

UNIT-V

Graphs: Isomorphism-Trees Spanning Trees-Binary Trees-Planar Graphs-Euler Circuits-Hamiltonian Graphs-Chromatic Numbers-For Color Problem.

Scope as in:

1. Discrete Mathematics for Computer Science- L. Mott, A. Kendal and T.P. Baker, 2nd Edition, Kiston(I-IV UNIT) .
2. Discrete Mathematical Structure- Kolman-Rusby-Ross, 5th Edition, Pearson Education

References:

1. Discrete Mathematics- Trembly Manohar
2. Discrete and Combinational Mathematics, Ralph. P.Grimaldi, Pearson Education India.
3. Discrete Mathematical Structure, G. Shanker Rao, NewAge International Pub.
4. Discrete Mathematics- Iyenger, Vikas Publications.
5. Discrete Mathematics with Applications, Thomous Koshy, Academic Press Print of Elsevier India.
6. Discrete Mathematics Elementary and Beyond, L. Levasz, J. Pelikan, K. Vesztergombi, Springer.

7. Discrete Mathematics with Graph Theory- Edgar G. Goodaire, Michael M. Palmenter, PHI.

Outcomes:

- The students become familiar with concepts of discrete mathematics.
- The students attain the ability to use this knowledge to understand and to solve many problems on other subjects like galois theory.

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L	T	P	C
4	0	0	3

205(ii). ADVANCED DIFFERENTIAL EQUATIONS

L: 4, P: 0, Credits: 3

Pre Requisites: Analysis- I and TODE.

Objectives:

- To the students concepts of more advanced deferential equations including linear as well as non linear.

UNIT-I

Systems of Linear Differential Equations: Introduction- System of first order equations- Model for arms competition between two nations- Existence and uniqueness theorem- Fundamental Matrix- Non homogeneous linear systems- Linear systems with constant coefficients- Linear systems with periodic coefficients.

UNIT-II

Existence and Uniqueness of Solutions: Introduction- Preliminaries- Successive Approximations- Picard's Theorem- Continuation and dependence on initial conditions- Existence of solutions in the large- Existence and uniqueness of solutions of systems- Fixed point method.

UNIT-III

Boundary Value Problems: Introduction- Sturm Liouville problem- Green's Function- Applications of Boundary value problems- Picard's Theorem.

UNIT-IV

Oscillations of Second Order Equations: Fundamental Results- Sturm's comparison theorem- Elementary linear oscillations- Comparison theorem of Hille wintner- Oscillations of $x'' + a(t)x = 0$.

UNIT-V

Stability of Linear and Nonlinear Systems: Introduction- Elementary critical points- System of equations with constant coefficients- Linear equation with constant coefficients- Lyapunov Stability- Stability of Quasi linear systems- Second order linear differential equations.

Scope as in:

1. Text book of ordinary differential equations- V. Lakshmikantam, S.G. Deo and V. Raghavendra, Second Edition, Tata Mc Graw –Hill.
2. Ordinary Differential equations- with applications in biology and engineering- M .Rama Mohan Rao and Shahi Ahamed, Affiliated East-West Press Pvt. Ltd.
3. Theory of Ordinary Differential Equations- Randal H.Cole Appleton, Century-Crafts, New York (1968).

References:

1. Theory of Ordinary Differential Equations- Earl.A. Coddington, PHI.

Outcome:

- The student can perform phase plane analysis, analyze systems of equations. For example linearising and non linear equations.

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4	0	0	3

205(iii). GALOIS THEORY

Pre Requisites: Algebra.

Objectives:

- To teach the students advanced algebra like Galois Theory and extension fields.

UNIT-I

Field Theory: Field definition and examples- Irreducible polynomials and Eisentein criterion- Adjunction of roots.

UNIT-II

Algebraic extensions- Algebraically closed fields**- Normal and separable extensions**: splitting fields

UNIT-III

Normal extensions- Multiple roots- Finite fields- Separable extensions

UNIT-IV

Galois Theory: Automorphism groups and fixed fields- Fundamental Theorem of Galois theory- Fundamental theorem of algebra.

UNIT-V

Applications of Galois Theory to classical problems: Roots of unity and cyclotomic polynomials- Cyclic extensions- Polynomials solvable by radicals.

Scope as in:

1. Basic Abstract Algebra- P.B. Bhattacharya, S.K. Jain, S.R. Nagpaul, Second Edition, Cambridge University Press.
2. Topics in Algebra- I.N. Herestein, John Willey-

References:

1. Galois Theory, second edition- J. Rotman, Springer.
2. Algebra- M.Artin, PHI.
3. Algebra Contemporary Abstract- Joseph A. Gallian, Narosa.
4. Algebra- Serge Lang, Springer.
5. Basic Algebra- P.B. Cohn, Springer.

Outcome:

Students can take subjects like coding theory by knowing Galois Theory.

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2	0	6	2

206- DATA STRUCTURES THROUGH 'C'

Pre Requisites: No Pre Requisites. Foundation Course

Objectives:

- Assess how the choice of data structures and algorithm design methods impacts the performance of programs.
- Choose the appropriate data structure and algorithm design method for a specified application.
- Solve problems using data structures such as linear lists, stacks, queues, , binary trees, binary search trees, and graphs and writing programs for these solutions.

UNIT-I

Array and Records - Storages structures for arrays strings- sting operations- sparse matrices representation records- Linear data structures- Linear lists- operations on linear lists sequential allocation and linked allocation linked lists- single linked lists- double linked lists- insertion and deletion operations- simple applications of linked lists- multiple linked structures- Circular Linked Lists.

UNIT-II

Stacks - Stack operations- array and pointer implementations of stacks- simple applications of stacks - infix to postfix expression conversions- postfix expression evaluation recursion.

UNIT- III

Queues - Queue operations- array and pointer implementation of queues- circular queues- insertion and deletion operations on circular queues- Simple applications of queues.

UNIT-IV

Non Linear Data Structures - Trees and Graphs - Tree terminology- Binary trees- representations of binary trees- recursive and non recursive traversals of binary trees- Graphs-
Terminology- representation of graphs- depth first and breadth first search of graph.

UNIT-V

Searching - Linear search- binary search- **sorting** - Bubble sort- selection sort- insertion sort- merge sort- Quick Sort- heap Sort. Time and Space complexity-definition- time complexity of simple algorithms (Elementary treatment only).

Scope as in:

1. An introduction to data structures with application M.C.M.- Trem Bay Ad Sorenson.

Reference:

1. DataStructure- Kochen
2. Data Structure- Behrouz.A.Forouzan- Richard F.Gilberg.
3. Programming in ANSI E. Balaguruswamy.

Outcome:

- To describe the usage of various data structures
- To explain the operations for maintaining common data structures

- To write programs using linked structures such as List, trees, and graphs
- To analyze algorithms and to determine algorithm correctness and time efficiency class
- To demonstrate various methods of organizing large amounts of data.
- To design and apply appropriate data structures for solving computing problems

Lab Practice:-

1. Implement the following data structures using Arrays.
   i) Stacks
   ii) Linear Queues
   iii) Circular Queues
   iv) Dequeue
2. Implement Polynomial addition and multiplication with linked list sparse matrix.
3. Implement binary search tree using linked list and perform the following operations.
   i) Insertion
   ii) Deletion
   iii) Inorder Traversal
   iv) Preorder Traversal
   v) Preorder Traversal
4. Singly Linked list and doubly lists.
   i) Insertion
   ii) Deletion
   iii) Lockup
5. i) Implement Stack using Linked list.
   ii) Implement Queue using Linked list.
6. Implement the following sorting Techniques.
   i) Bubble sort
   ii) Insertion sort
   iii) Quick sort
   iv) Heap sort
7. Implementation the following Searching method.
   i) Sequential Search
   ii) Binary Search
   iii) Fibonacci
8. i) Conversion of Infix expression to Postfix notation.
   ii) Simple expression evaluation that can handle +--- /and*

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301- TOPOLOGY

Pre Requisites: Analysis- I and Analysis- II

Objectives:

- The object of Topology is to stress on the ideas of abstraction, aesthetics and the development of mathematical tools and the use of the language of mathematics.

UNIT-I

Topological Spaces: The definition and some examples – Elementary concepts – Open bases and open subbases – Weak topologies.

UNIT-II

The function algebras C (X, R) and C (X, C)

Compactness: Compact spaces – Product of spaces – Tychonoff's theorem and locally compact spaces.

UNIT-III

Compactness for metric spaces – Ascoli's theorem.

Separation: T_1- spaces and Hausdorff spaces.

UNIT-IV

Completely regular spaces and normal spaces – Urysohn's lemma and the Tietze extension theorem – The Urysohn imbedding theorem- The Stone Cech compactification.

UNIT-V

Connectedness: Connected spaces – The components of a space – Totally disconnected spaces – Locally connected spaces.

Scope as in:

1. Introduction to Topology and Modern Analysis- G.F. Simmons, Tata Mc graw-Hill.

References:

1. Topology -James R. Munkers, PHI.
2. General Topology- Kelley, Springer.
3. Topology- Dugundji, Cambridge University Press.
4. Principles of Topology- Fred.H.Groom, Cengage Learning.

Outcome:

- Students should be familiar with basic concepts of topology.
- Student should gain mathematical maturity.
- Students should become competent in writing proofs.
- Apply special imagination to theory.

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4	0	0	4

302- PROBABILITY AND STATISTICS

Pre Requisites: No Pre Requisites. Foundation Course.

Objectives: The student will be able to:

- Define experiment, outcome, event, probability and equally likely.
- Restate the formula for finding the probability of an event.
- Determine the outcomes and probabilities for experiments.
- Interact with die rolls and spinners to help predict the outcome of experiments.
- Distinguish between an event and an outcome for an experiment.
- Recognize the difference between outcomes that are equally likely and not equally likely to occur.

UNIT-I

Probability: Sample spaces and events - Basic set theory - Definitions of probability - Axioms of probability - Joint probability (addition Theorems) - Conditional probability (Multiplication Theorem) - Total probability - Baye's Theorem - Independent events – random variables - Introduction - Types of Random variables - Discrete Random variable.
Probability Distribution Function - Properties of Distribution Function - Probability Density Function (PDF) - Properties of Density Function - Continuous Random Variables - Random vector concepts - Joint distribution function - Joint Density function statistical parameters Mathematical expectation - Variance - Skew-Moments - Moment generating function - Characteristics function - Chebyshev's inequality Probability and distribution: Binomial distribution - Poisson distribution - Uniform distribution - Normal distribution - Exponential distribution.

UNIT-II

Regression And Correlation: Correlation Analysis- Types of correlation - Positive and negative correlation -Simple - partial and Multiple Correlation - Linear and Non-Linear Correlation - Methods of Studying Correlation - Scatter Diagram correlation - Graphic method – Karl-Pearson's Coefficient of correlation Rank Correlation - Partial correlation - Multiple Correlation - Regression Analysis.

UNIT-III

Tests of statistical hypothesis - large sample tests - Introduction - Statistical Hypothesis -test of a statistical hypothesis- Procedure of Testing Hypothesis - Set up a Hypothesis - Set up a Suitable significance Level - Setting's test criterion - Doing computations - Making decisions - Type I and Type II errors - Two-tailed and one-tailed test of Hypothesis - Large sample tests: Test of significance of single mean - Test of significance for difference of standard deviation - Test of Significance for single proportion - Test of significance for difference of proportions.

UNIT-IV

Tests of statistical hypothesis small sample tests: Introduction -student's t-distribution- Properties of t-distributing - test of significance of single mean - Test of significance for inference between two mean of independent sample_ Test of significance for difference between Two Means (dependent samples)- Test of Significance of an observed correlation

coefficient - F-test for equality of Population Variance - Chi-square distribution : Properties of chi-square distribution - Applications of Test of a statistical χ^2 distributions - Chi-square test for goodness of fit - Conditions for-applying χ^2 test - degree of freedom -Chi-square test for independence of attributes.

UNIT-V

Time series analysis - Introduction - Significance of Time series analysis - Components of time series - Secular Trend: Freehand of Graphic Method - Semi average Method - Method of Moving Averages- Method of Least Square - Straight linear and non-linear trends - Logarithmic methods - Exponential trends - Growth curves - Seasonal variations: Method of Simple averages Ratio-to-trends method - Ratio-to-Moving average method -Random process - Classification -Statistical of Random process- Stationary random process - Erodic Random process - Correlation Techniques - Auto-correlation - Auto-Covariance - Properties of Auto-correlation Cross-correlation- Cross-covariance - properties of Cross-correlation.

Scope as in:

1. Fundamentals of Mathematical Statistics- Gupta and Kapoor.
2. Probability and Random Process- Murugeshan

Reference:

1. Probability and Statistics for Engineers and Scientists- Miller & Freund.
2. Probability and Statistics- Anthony J Hayter.
3. Introduction to Probability chartes M.Grinstead- J. Laurie Snell.

Outcomes:

The student will be able to:

- Define certain event, impossible event.
- Describe and list the contents of a standard deck of 52 playing cards.
- Examine the probabilities of experiments with certain outcomes.
- Examine the probabilities of experiments with impossible outcomes
- Evaluate interactive die rolls and spinners in relation to certain and impossible events.
- Explain the difference between certain and impossible events.
- Compute the probability of a certain event.
- Compute the probability of an impossible event.

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4	0	0	4

303- PARTIAL DIFFERENTIAL EQUATIONS

Pre Requisites: Ordinary differential equations and Linear Algebra

Objectives:

- Where and how PDEs arise in applications.
- Fundamental concepts of PDE theory.
- Analytical methods for solving PDEs

UNIT-I

Simultaneous Differential equations of the first order and the first degree in three variables Method of solution of dx/P = dy/Q = dz/R – orthogonal trajectories of a system of curves on a surface – Partial differential forms and equations.

UNIT-II

Partial Differential Equations of the First Order: Origins of First Order Partial Differential Equations – Cauchy's problem for first order equations – Linear equations of the first order – Nonlinear Partial Differential equations of the first order – Cauhy's method of Characteristics – Charpit's Method –Jacobi's method.

UNIT-III

Partial Differential Equations of the Second Order: Linear Partial Differential Equations with constants coefficients – Characteristic curves of second order equations in three variables – The solution of linear hyperbolic equation – Separation of variables.

UNIT-IV

Laplace Equations: The occurrence of Laplace's equation in physics Elementary solution of Laplace equation – Boundary Value Problems Separation of variables – The two dimensional Laplace equation.

UNIT-V

The Wave equation: The occurrence of the Wave equation in Physics – Elementary solution of the one – dimensional wave equation. Green's function for the wave equation.

Scope as in:

1. Elements of Partial Differential Equations- I.N. Sneddon, Mc Graw-Hill.

Reference:

1. Partial Differential Equations- L.G.Petrovski.
2. Partial Differential Equations An Introduction- Bernard Epstein, Tata Mc Graw -Hill.
3. Partial Differential Equations- Methods and Applications- Robert, C.Mc Owen, Second Edition, Pearson Education.

Outcome:

- Describe real-world systems using PDEs.
- Solve first order PDEs using the method of characteristics.
- Determine the existence, uniqueness, and well-posedness of solution of PDEs.
- Solve linear second order PDEs using canonical variables for initial-value problems, Separation of Variables and Fourier series for boundary value problems

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304- OPTIMIZATION TECHNIQUES

Pre Requisites: Linear Algebra

Objectives:

- To lay a strong foundation in various optimization techniques. So that the student can solve problems that arise in subjects like fluid dynamics.

UNIT-I

Linear Programming problem Formation, General formation of Linear Programming, problem, convex set, Extreme points of a Convex set, convex Hull. Linear programming: Simplex method, computational procedure of simplex method, Artificial variables Techniques, Two Phase Method, simple way for two phase simplex method , Big M-Method. Method to resolve degeneracy, special cases of unbounded solutions, Non existing feasible solutions. Revised Simplex M-method, duality in linear programming, Fundamental duality theorem, existence theorem.

UNIT-II

Transportations Models: Matrix form of transportation problem, existence of feasible solution, existence of optimal solution, loops in transportation table and their properties, The initial basic solution in transportation table and their properties, The initial basic feasible solution to transportation problem, methods for initial Basic feasible solution, Moving towards optimum solution, To examine the initial basic feasible solution for Non-degeneracy, Determination of Net evaluations, the Optimality test, Degeneracy in Transportation problem, Unbalanced transportation problem.

UNIT-III

Assignment, Problem: Mathematical formulation of Assignment problem, Fundamental theorems Hungarian Method for Assignment problem Assignment Algorithm unbalanced assignment problem, The Maximal Assignment problem, Restrictions on Assignment.

UNIT-IV

Replacement Models: The Replacement problem, Failure Mechanism of items, Replacement policy for items whose maintenance cost increases with time and money value is constant.

UNIT-V

Job Sequencing: Terminology and notations, Principle Assumptions, solution of sequencing problem processing n jobs through two, three and m machines, processing two jobs through 'm' machines (Graphical method).

Scope as in:

1. Operations Research by S.D.Sharma.

Reference:

1. Data Structures in Pascal- Horowitz And Sahni, Galgotia publications.
2. Linear programming by M.K.Venkata Raman.

Outcome:

- The student can apply optimization techniques to solve and understand problems in statistics, fluid dynamics etc.

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4	0	0	3

Departmental Elective- III
305(i)- DISCRETE TIME CONTROL SYSTEMS

Pre Requisites: Differential Equations.

Objectives:

- To train and motivate the students towards mathematical modeling and to understand various real world problems which use applications of mathematics

UNIT-I

Introduction to Discrete Time Control Systems: Introduction - Digital Control Systems - Quantizing and Quantization Error - Data Acquisition- Conversion and Distribution Systems.
The Z Transform : Introduction - The Z transform - Z Transforms of Elementary Functions - Important theorems of the Z Transform. The Inverse Z transform- Z transform Method for solving difference equations.

UNIT-II

Z-Plane Analysis of Discrete - Time Control Systems: Introduction - Impulse Sampling and data hold - Obtaining the Z Transform by the Convolution integral Method - The pulse transfer function .

UNIT-III

Design of Discrete-Time Control Systems by Conventional Methods: Introduction - Mapping between the S plane and the Z plane - Stability analysis of closed - Loop systems in the Z plane.

UNIT-IV

State-Space Analysis: Introduction - State - Space representations of discrete time systems - Solving discrete-time state - Space equations - Pulse-transfer-function matrix - Discretization of continuous- time state - space equations - Liapunov stability analysis.

UNIT-V

Pole placement and observer design: Introduction - Controllability - Observability - Useful transformations in state - Space analysis and design - Design via pole placement - State observers.

Scope as in:

1. Discrete - Time Control Systems- Katsuhiko, 2nd edition- Ogata Prentice, Hall of India Pvt, New Delhi.

References:

1. Digital Control using Digital Signal Processing- Farzad Nekoogar & G Moriarty Prentice Hall PTR- Upper Saddle Rover- New Jersey.

Outcome:

- After the completion of this course the student can apply these techniques to learn and understand mathematical modeling, dynamical systems and mathematical biology.

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305(ii)- DIFFERENTIAL EQUATIONS AND DYNAMICAL SYSTEMS

Pre Requisites: Theory of Ordinary differential equations

Objectives:

By the end of the course, you would/should have:

- Learned and used various tools for the analysis and control of nonlinear systems.
- Got a feeling and gained insight into the complexity of nonlinear systems.
- Known and played around with a wide variety of interesting, inherently nonlinear examples.

UNIT –I

Linear Systems: Uncoupled Linear Systems- Diagonalization- Exponentials of Operators- The Fundamental Theorem for Linear Systems- Linear Systems in R^2- Complex Eigen Values- Multiple Eigen Values- Jordan Forms- Stability Theorem- Non homogeneous Linear Systems.

UNIT-II

Nonlinear Systems: Local Theory- Some Preliminary Concepts and Definitions- The Fundamental Existence- Uniqueness Theorem- Dependence on Initial Conditions and Parameters- The Maximal Interval of Existence- The Flow Defined by a Differential Equation- Linearization- The Stable Manifold Theorem- The Hartman- Grobman Theorem- Stability and Liapunov Functions- Saddle- Nodes- Foci and Centers- NonHyperbolic Critical Points in R^2- Gradient and Hamiltonian Systems.

UNIT-III

Nonlinear Systems: Global Theory- Dynamical Systems and Global Existence Theorems- Limit Sets and Attractors- Periodic Orbits- Limit Cycles and Separatrix Cycles- The Poincare Map- The Stable Manifold Theorem for Periodic Orbits- Hamiltonian Systems with Two Degrees of Freedom- The Poincare Bendixson Theory in R^2- Lieanard Systems – Bendixon's Criteria- The Poincare Sphere and separatrix Configurations- Index Theory.

UNIT-IV

Nonlinear Systems: Bifurcation Theory- Structural Stability and Piexoto's Theorem- Bifurcations at Non Hyperbolic Equilibrium Points- Hopf Bifurcation and Bifurcation of Limit Cycles from a Multiple Focus.

UNIT-V

Bifurcations at Non Hyperbolic Periodic Orbits- One Parameter Families of Rotated Vector Fields- The Global Behavior of One Parameter Families of Periodic Orbits- Homoclinic Bifurcations- Melnikov's Method.

Scope as in:

1. Differential Equations, Dynamical Systems and an Introduction to Chaos- M.W.Hirsch, Stephens Snale, RIdevaney, ELSE WEAR Press.

References:

1. Differential Equations and Dynamical Systems- Lawrence Perko, Springer.

Outcome:

- Knowledge. The student has knowledge of basic concepts and methods from the theory of differential equations and dynamical systems, including analytical and geometrical techniques for the study of qualitative properties of solutions. In particular, the student is familiar with linear and nonlinear systems, existence and uniqueness, continuous dependence, phase plane analysis, equilibria, limit cycles, stability, Lyapunov's Direct Method, index theory, the Poincaré-Bendixson theorem, the additional topics and examples of applications.
- Skills. The student is able to apply his or her knowledge to the study of concrete examples. The student masters central techniques of proof and is able to apply these to related problems.

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305(iii)- ARTIFICIAL NEURAL NETWORKS

Pre Requisites: Linear algebra.

Objectives:

The student will able to know the following topics.

- Basic neuron models, Basic neural network models, multilayer perceptron, **Basic learning algorithms**: the delta learning rule, the back propagation algorithm, self-organization learning, **Applications**: pattern recognition, function approximation, information visualization, etc.

UNIT-I

Basics of Artificial Neural Networks: Characteristics of Neural Networks- Historical Development of Neural Network Principles- Artificial Neural Networks: Terminology- Models of Neuron- Topology- Basic Learning Laws.

UNIT-II

Activation and Synaptic Dynamics: Introduction- Activation Dynamics Models- Synaptic Dynamics Models- Learning Methods- Stability and Convergence- Recall in Neural Networks.

UNIT-III

Functional Units of ANN for Pattern Recognition Tasks: Pattern Recognition Problem- Basic Functional Units- Pattern Recognition Tasks by the Functional Units.

UNIT-IV

Feedforward Neural Networks: Introduction- Analysis of Pattern Association Networks- Analysis of Pattern Classification Networks- Analysis of Pattern Mapping Networks- Summary and Discussion.

UNIT-V

Feedback Neural Networks: Introduction- Components of a Competitive Learning Network- Analysis of Feedback Layer for Different Output Functions- Analysis of Pattern Clustering Networks- Analysis of Feature Mapping Network- Summary.

Scope as in:

1. Artificial Neural Networks- B. Yegnanarayana, Prentice Hall of India Pvt. Ltd, New Delhi.

References:

1. Neural Networks, Algorithms, Applications and programming Techniques- James A. Freeman/ David M. Skapura, Pearson Education, Inc, NewDelhi 1991.
2. Introduction to Artificial Neural systems- Jacek and Zurada, Jaico Publishing Home 1997.
3. Neural Networks and Fuzzy Systems- Bart Kosko.

Outcome:

- After this course, the student should be able to know how to use neural networks for solving different problems related to pattern recognition, function approximation, data visualization, and so on.

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2	0	6	2

306- MAT LAB-I

Pre Requisite: No Pre Requisites. Foundation Course

Objectives:

- The goal of this course is to introduce students to the fundamental concepts of Scientific Programming using MATLAB and we introduce the necessary mathematical concepts as we go.
- The course will cover the syntax and semantics of MATLAB including data types, control structures, comments, variables, functions, and other abstraction mechanisms.

UNIT-I

Introduction to MAT LAB: Starting and ending a MATLAB-MATLAB Environment- Help future- Types of Files- Platform- Search Path.

Constants, Variables and Expression:- Character Set- Data Types- Constants and Variables- Operators- Hierarchy of Operations- Built-in Functions- Assignment Statement- Illustrative Programs.

UNIT-II

Vectors and Matrices:-Scalars and Vectors- Entering Data in Matrices- Line Continuation- Matrix Subscripts/Indices- Multidimensional Matrices and Arrays- Matrix Multiplications- Generation of Special Matrices- Matrix and Array Operations - Functions with Array Inputs- Structure Arrays - Cell Arrays.

Polynomials:-Entering a polynomial- Polynomial Evolution- Roots of a Polynomial- Polynomial Addition and Subtraction- Polynomial Multiplication- Polynomial Division- Formulation of Polynomial Equation - Characteristic Polynomial of a Matrix- Polynomial Differentiation- Polynomial Integration- Polynomial Curve fitting- Evolution of Polynomials with Matrix Arguments.

UNIT-III

Input-output Statements:-Data input- Interactive Inputs- Reading/Storing File Data- Output Commands- Low-level Input-Output Functions.

MATLAB Graphics:-Two Dimensional Plots- Multiple Plots - Style Option -Sub plots- Specialized Two–Dimensional Plots- Three dimensional Plots.

UNIT-IV

Loops: While loop- For loop- Break and Continue Statements- Nesting loops- Branches Control Structures.

Writing Programs and Functions:-MATLAB Editor- MATLAB Programming- Function Subprograms- Types of Functions - Function handles - Errors and Warnings.

UNIT- V

Database Tool Box:-Create a Database and Data Source- Export data from MATLAB Workspace to Database- Import data from Data base to MATLAB workspace - Sub Query from Multiple tables Using VQB (Visual Query Builder) - MATLAB functions with Examples.

Scope as in:

1. MATLAB and Its Application In Eginerring- Rajkumar Banasal, Ashok Kumar Geo, Manoj Kumar Sharma, Pearson Publications.

References: Numerical Methods using MATLAB- John H. Mathews, D.fink, PHI.

Outcome:
Students who successfully complete this course will:

- Become familiar with general concepts in computer science
- Gain an understanding of the general concepts of programming
- Obtain a solid foundation in the use of MATLAB.

Lab Practice:-

1. Let a 4X3 Matrix A= $\begin{bmatrix} 2 & 3 & 4 \\ 3 & 4 & 5 \\ 4 & 5 & 6 \\ 5 & 6 & 7 \end{bmatrix}$, Using matlab Commands
   a) Delete a 1st row of A
   b) Delete the 1st &2nd columns of all rows of matrix.
   c) Replace the elements A(3,4), A(4,3) with 9 and 8.
2. Express the following sets of algebraic equation in the matrix form AY=B.

$$\begin{aligned} x_1 + x_2 - x_3 &= 2 \\ -x_1 + 3x_2 - x_3 &= 2 \\ 3x_1 - 5x_2 - 2x_3 &= 0 \end{aligned} \quad \& \quad \begin{aligned} x_1 + x_2 + x_3 &= 4 \\ -x_1 + 3x_2 - x_3 &= 4 \\ 4x_1 - 4x_2 &= 0 \end{aligned}$$

   a) Find the inverse of both matrices.
   b) Obtain the solution for the variables $x_1, x_2 \& x_3$.
   c) Find the eigen values and eigen vectors of both matrices.
   d) Find rank, trace and transpose of both matrices.
3. Draw multiple plots using hold command and also use legend command.
4. Draw the multiple plots of the following curves $y1 = \sqrt{x^2 + 1}$, $y2 = 5X + 20$, using Line command X varies from 0 to 100 and step size is 10.
5. Draw the graph of the equation Y=3X + 5 for X varies from 0 to 5, add label to it using gtext command .
6. Plot the curve given by the equation y=sin(x) as X varies from 0 to 2*pi also label the X and Y axis produce a suitable title to plot and also show grid lines on the plot.
7. Illustrate the use of pie function to show the concentration of different industries in the regions as per the following data.

Name of the industry	No. of Industrial Units
Cement	4
Textile	8
Software	20
Chemical	2
Telecom	7
Banking	10

8. Divide the figure window into 4 sub windows and plot the following functions
   i) Plot V v/s I , where V=4*I and I=1,2,3,4
   ii) Plot Y v/s X, where $Y=X^2$ and X=1,2,3,4
   iii) For t=0 : 2*pi in step t=pi/60, plot sin(t) v/s t.
   iv) For t=0 : pi/30 : 2*pi, plot cos(t) v/s t
9. Plot the graph for the equation $y=X^3+2X^2-5$, X varies from -10 to 10, use gtext command to write this equation on the curve plotted.
10. Write a program to plot the curve for equation $A=10e^{-0.2t}$ for t=0 to 50, show the grid lines on the graph.
11. Plot a bar graph to show the comparison of average temperature in city A, B, C for the months from september to February.

	City - A	City - B	City - C
September	31	28	24
October	29	26	22
November	28	25	20
December	27	24	16
January	26	22	17
February	29	25	20

12. Plot the following function on polar plot, the function is $f(\theta)= \sin(4\theta)$ for $-pi/2 \le \theta \le pi/2$, where θ is in Radians.

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L	T	P	C
4	0	0	4

401- FUNCTIONAL ANALYSIS

Pre Requisites: Analysis- I and Analysis- II.

Objectives:

- The objective of the module is to study linear mappings defined on Banach spaces and Hilbert spaces, especially linear functionals and some sequence spaces. In particular, the four big theorems in functional analysis, namely, Hahn-Banach theorem, uniform boundedness theorem, open mapping theorem and Banach-Steinhaus theorem will be covered.

UNIT- I

Normed Space- Banach Space: Normed Space- Banach Space –Further Properties Of Normed Spaces –Finite Dimensional Normed Spaces and Subspaces –Compactness and Finite Dimension.

UNIT-II

Linear Operators -Bounded and Continuous Linear Operators – Linear Functionals –Linear Operators and Functionals on Finite Dimensional Spaces –Normed Spaces of Operators-Dual Space.

UNIT-III

Inner Product Spaces. Hillbert Spaces: Inner Product Space. Hilbert Space - Further Properties Of Inner Product Spaces –Orthogonal Complements and Direct Sums – Orthonormal Sets and Sequences –Series Related to Orthonormal Sequences and Sets – Total Orthonormal Sets and Sequences –Representation of Functionals on Hilbert Spaces.

UNIT-IV

Fundamental Theorems for Normed and Banach Spaces: Zorn's Lemma-Hahn-Banach Theorem-Hahn-Banach Theorem for Complex Vector Space and Normed Spaces-Application to Bounded Linear Functionals on C[a,b] -Adjoint Operator-Reflexive Spaces-Category Theorem- Uniform Boundedness Theorem.

UNIT-V

Strong and Weak Convergence-Convergence of Sequences of operators and Functionals-Application to Summability of Sequences -Weak Convergence –Open Mapping Theorem – Closed Linear Operators- Closed Graph Theorem.

Scope as in:

1. Introductory Functional Analysis with Applications– Erwin Kreyszig, John Wiley.

References:

1. Introduction to topology and modern Analysis- G.F Simmons – Tata Mc Graw-Hill.
2. Functional Analysis- B.V. Limaye.
3. A First Course in Functional Analysis– Goffman and Pedrick.
4. Operator Theory– S.K. Berberian– Springer.
5. Functional Analysis-A problem oriented approach– V.K. Krishnan, PHI
6. Topics in Functional Analysis and Applications- S. Kesavan, John Wiley.

Outcome:

This is a basic Foundation course in functional analysis with which student gets a better understanding of advanced courses in ODE and PDE.

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402- OPERATIONS RESEARCH

Pre Requisites: Optimization Techniques

Objectives:

- Model decision making problems using major modeling formalisms of artificial intelligence and operations research, including propositional logic, constraints, linear programs and Markov processes
- Evaluate the computational performance of search, satisfaction, optimization and learning algorithms.
- Apply search, satisfaction, optimization and learning algorithms to real world problems.

UNIT-I

Theory of Games: Characteristics of Games Theory, Basic definitions. Minimax Criterion and optimal strategy, saddle point optional strategies and value of game, solution of games with saddle points, Rectangular Games without saddle point, Minimax principle, Equivalence of Rectangular Game and Linear Programming, Fundamental theorem of Game theory, solution of m x n games by Linear programming, Two by two Games without Saddle point by Arithmetic method, Dominance method, Graphical method for 2xn and nx2 Games matrix method, Algebraic method, iterative method.

UNIT-II: Dynamic Programming: Decision Tree and Bellman's principles of optimality, solution of problem with Finite number of stages, Model 1 : Minimum path problem, Model II Single additive constraint, Multiplicatively Separable return. Model III. Single additive constraint, Additively separable return - Model IV: Single Multiplicative constraint, Additively separable return. Model V: System involving more than one constraint, Application in Linear Programming.

UNIT-III

Inventory Production Management: Introduction - Definition - Types of Inventory - Inventory decisions - How to develop an inventory model. Costs involved in Inventory problems - Variables in inventory problem - classification of characteristics of inventory systems . A list of symbols used Graphical method. The EOQ model without shortage.

UNIT-IV: Project scheduling by PERT/ CPM: Introduction, Basic Difference between PERT and CPM, Construction of the net work, critical path analysis, Floats of an activity, Three time estimates for PERT.

UNIT-V

Queueing theory: Introduction Queuing system, queuing problem, Transient and steady states, Traffic intensity, Distributions of Arrivals, Poisson process (Pure Birth process) properties of Poisson process of Arrivals, Distribution of inter, Arrival Linear (exponential process).Markovian property of inter arrival times, Distribution of Departure (Pure Death process) Classification of Queuing Models Solution of Queuing models and limitations for its applications. Model (M/M/1) (/FCFS) Birth and death model.

Scope as in:

1. Opertions Research by S.D.Sharma.

References:

1. Operations Research by Taha Handi, Prentice –Hall.
2. Operations Research by Prem Kumar Gupta S.Chand.

Outcome:

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

- Describe at an initiative level the process of artificial intelligence and operations research: a real-time cycle of problem understanding, formulation, solution and implementation.
- Formulate simple reasoning, learning and optimization problems, in terms of the representations and methods presented.
- Manipulate the basic mathematical structures underlying these methods, such as system state, search trees, plan spaces, model theory, propositional logic, constraint systems, Markov decision processes, decision trees, linear programs and integer programs.
- Demonstrate the hand execution of basic reasoning and optimization algorithms on simple problems.
- Formulate more complex, but still relatively simple problems, and apply implementations of selected algorithms to solve these problem.
- Evaluate analytically the limitations of these algorithms, and assess tradeoffs between these algorithms.

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4	0	0	4

403- THEORY OF COMPUTATION

Pre Requisites: No Pre Requisites. Foundation Course.

Objectives:

- The primary objective of a Theory of Computation (TOC) course is to introduce the fundamental mathematical and computational principles that are the foundation of computer science. These include topics such as Turing machines, Automata, grammars and formal languages, decidability, halting problem, the P = NP question and NP-Completeness reductions.

UNIT-I

The Theory of Automata: Definition of an automata- Description of a Finite Automation- Transition Systems- Properties of Transition Functions- Acceptability of a string by a finite Automation- Non Deterministic finite State Machines- The Equivalence of DFA and NDFA- Mealy and Moore models- Minimization of Finite Automaton.

UNIT-II

Formal Languages: Basic definitions and examples- Chomsky classification of Languages- Languages and their relation- Recursive and recursively enumerable sets- operations of languages- Languages and Automaton.

UNIT-III

Regular sets and Regular Grammars: regular expressions- Finite Automata and regular expressions- Pumping lemma for Regular sets- Application of Pumping lemma- Closure properties of regular sets- Regular sets and Regular grammars.

UNIT-IV

Context-free Languages: Context-free languages and derivation trees- Ambiguity in Context-free Grammars- Simplification of Context-free Grammars- Normal forms for Context-free Grammars.

UNIT-V

Turing Machines: Turing Machine model- Representation of Turing Machines- Languages Acceptability by Turing Machines- Design of Turing Machines- Universal Turing Machines and other modifications.

Scope as in:

1. Theory of Computer Science (Automata- Languages and Computation).
   Chapters: 2-3-4-5.1 to 5.4 and 7.1 to7.5 By K.L.P. Mishra- N. Chandrasekharan, Second Edition, PHI.

References:

1. Introduction to Automata theory-languages and computation- Hopcroft H E and Ullman J D.
2. Introduction to theory of computer science - Krishna Murthy , E.V, Affiliate East west press.

3. Elements of theory of computation- Lewis H.P & Papadimition C H. Printice Hall.
4. Theory of computation- T.Nagamallika & Raju, Sure publications Pvt Ltd.

Outcome:

- The foundation of the theory of computer science is learnt. Student is able to write programs on theory of automata after the completion of this course.

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4	0	0	4

404- ANALYTIC NUMBER THEORY

Pre Requisites: Algebra and Complex Analysis..
Objectives:

- It is to make the students to learn about basic number theory, number theoretic functions and their applications in the proof of prime number theory and in algebra

UNIT-I
Review of Basic Concepts of Number Theory (Not to be examined)
Arithmetical Functions and Dirichlet Multiplication: Introduction-The mobius function μ(n)-The eulertotient function ø(n)- A relation connecting ø and μ- A product formula for ø(n)-Dirichlet product of arithmetical functions- Dirichlet inverses and mobius inversion formula-The Mangoldt function $\wedge(n)$-Multiplicative functions- Multiplicative functions and Dirichlet Multiplication- The inverse of a completely multiplicative function-Liouville's function λ(n)-The divisor functions $\sigma_\alpha(n)$- Generalized convolution.

UNIT-II
Averages of Arithmetical functions: Introduction-The big oh notation. Asymptotic equality of functions- Eular's summation formula- Some elementary Asymptotic formulas- The Average order of d(n)- The Average order of the divisor functions $\sigma_\alpha(n)$-The average order of ø(n)-An application to the distribution of lattice points visible from the origin-The average order of μ(n) and $\wedge(n)$-The partial sums of a Dirichlet product- Application to μ(n) and $\wedge(n)$-Another identity for the partial sums of a Dirichlet product.

UNIT-III
Some Elementary Theorems on the Distribution of Prime Numbers: Introduction-Chebyshev's functions ψ (x) and v(x)- Relations connecting v(x) and π(x)- Some equivalent forms of the prime number theorem- Inequalities for π(n) and p_n- Shapiro's Tauberian Theorem- An Asymptotic formula for the partial sums $\sum_{p\le x}(1/p)$ - The partial sums of the Mobius function- Brief sketch of an elementary proof of the prime number theorem-Selberg's asymptotic formula.

UNIT-IV
Finite Abelian Groups and Their Characters: Definition- Examples of groups and subgroups- Elementary properties of groups- Construction of subgroups- Characters of finite abelian groups. The character group- The orthogonality relations for characters- Dirichlet Characters- Sums involving Dirichlet Characters- The non-vanishing of L(1-x) for real nonprincipal x.

UNIT-V
Dirichlet's theorem on Primes in Arithmetic Progressions: Introduction- Dirichlet's theorem for primes of the form 4n-1 and 4n+1 – The plan of the proof of Dirichlet's theorem-Proof of Lemma 7.4 - Proof of Lemma 7.5- Proof of Lemma 7.6- Proof of Lemma 7.8- Proof of Lemma 7.7-Distribution of primes in arithmetic progressions.

Scope as in:

1. Introduction to Analytic Number Theory– Tom.M.Apostol, Narosa.

References:

1. Analytic Number Theory – Raymond Ayoub, American Math. Society .
2. An Introduction to the Theory of Numbers – G.H Hardy, E. M Wright, Oxford University Press.

Outcome:

- After completion of this course students can learn the applications number theory in advanced subjects like cryptography, cryptology, and coding theory.

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4	0	0	3

Departmental Elective - IV
405(i). MEASURE AND INTEGRATION

Pre Requisites: Analysis- I and Analysis- II.

Objectives:

- This course is intended to train the students in the advanced analysis whose usage is multidisciplinary.

UNIT-I

Algebra of Sets: σ- Algebra**. Lebesgue Measure**: Introduction - Outer measure - Measurable sets and Lebesgue measure - A non measurable sets- Measurable functions - Little wood's three principles.

UNIT-II

The Lebesgue Integral: The Riemann Integral - The Lebesgue integral of a bounded function over a set of finite measure.

UNIT-III

The integral of a non-negative function - The general Lebesgue integral - Convergence in measure.

UNIT-IV

Differentiation and integration: Differentiation of monotone functions - Functions of bounded variation - Differentiation of an integral - Absolute continuity - Convex functions.

UNIT-V

Classical Banach Spaces: L^p spaces - Minkowski and Holder in equalities - convergences and completeness - Approximation in L^p Bounded Linear functional on the L^p - Spaces.

Scope as in:

1. Real Analysis- H.L. Royden, 3 rd Edition, PHI.

References:

1. Measure Theory- P.R. Halmos- Springer.
2. Measure Theory and Integration- G. de Berra, New Age International (P)Ltd.
3. Measure and Integration- Inder K. Rana, Narose Publishing House.
4. Fundamentals of Real Analysis- Sk. Berberian, Springer.

Outcome:

- After this advanced analysis course students are able to work with theories involving advanced ordinary differential equations and their applications.

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L	T	P	C
4	0	0	3

405(ii).DYNAMIC MODELS AND CONTROL OF BIOLOGICAL SYSTEMS

Pre Requisites: TODE and PDE.
Objectives:

- To introduce students to the application of mathematical modeling in the analysis of biological systems comprising populations of molecules, cells and organisms.
- To show how mathematics, statistics and computing can be used in an integrated way to analyze Mathematical biology.
- To develop students' skills in algebraic manipulation, the calculus of elementary differential equations and statistical methods.
- To examine students in the theory of Mathematical biology at the end of the course.

UNIT-I
Basic Models: Introduction-biological Principles- Formulation of the Mathematical Model-Properties of Solutions- equilibrium Solutions- Stability Analysis- General Uptake function-Discussion.

UNIT-II
Chemostat versus the Lake: Introduction- Models Involving Time Delays- Time Delay Models in Growth Response- Global Stability- A Modified Model- Material Recycling with and without time delays- Finite Delays in Material Recycling- Distributed Delays-A More Realistic Model- Qualitative Properties of Solutions- Local Stability- Global Asymptotic Stability Results- Discussion.

UNIT-III
Instability Tendencies: Introduction- Instability Tendencies- Instability Characteristics of Model- Equilibria and Instability- Biocontrol Mechanisms- Discussion.

UNIT-IV
Self Regulation: Introduction- Qualitative Properties of Solutions- Persistence of Solutions-Global Asymptotic Stability Results- Oscillations and the Self-regulations.

UNIT- V
Properties of Solutions- Existence of Periodic Solutions- A Model with Discrete Delay in Growth Response- Stability Results- Discussion.

Scope as in:
1. Dynamic Models and Control of Biological Systems– V. Sree Hari Rao, P. Raja Sekhara Rao, Springer.

References:
1. Mathematical Modeling in Biology and Medicine- JN. Kapoor, East West Press.

Outcome:

At the end of the course, students should:

- have an enhanced knowledge and understanding of mathematical modeling in the analysis of biological systems;
- be better able to assess biological inferences that rest on mathematical
- be able to analyze data from experiments and draw sound conclusions about the underlying processes using their understanding of mathematics;

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L	T	P	C
4	0	0	3

405(iii)-FLUID MECHANICS

Pre Requisites: Mechanics.

Objectives:

- Develop an understanding of fluid dynamics in aerospace engineering as well as a variety of other fields.
- Learn to use control volume analysis to develop basic equations and to solve problems.
- Understand and use differential equations to determine pressure and velocity variations in internal and external flows.

UNIT-I

General Orthogonal Curve linear Coordinates: Arc length gradient- Divergence and curl in orthogonal coordinates- Laplacian kinematic of fluids in motion real fluid and ideal fluids- Velocity of fluid at a point- Stream lines and path lines- Steady flow and unsteady flow- Velocity potential- velocity vector- Local and partical of fluid- Conditions at a rigid boundary general analysis of fluid motion.

UNIT-II

Equations of Motion of a Fluid: Pressure at a point in a fluid at rest- Pressure at a point in a moving- Fluid conditions at boundary of two in viscid in compressive fluids- Euler's equation of motion- Bernoulli's equation- Steady motion under conservative body forces- Potential theorems- flow involving axial summitry- special two dimensional flows- impulsive motion- Further aspects of vortex motion.

UNIT-III

Three Dimensional Flows: Sources, Sinks, Doublets, Images in a rigid infinite plane- Images in solid spheres- ax symmetric flows- Stokes stream function for ax symmetrical irrotational motions.

UNIT-IV

Two-Dimensional Flows: Meaning of two dimensional flow- Use of cylindrical polar coordinates- Stream function- Complex potential for two dimensional irrotational in compressive flow- Complex velocity potentials for standard two dimensional flow.

UNIT-V

Uniform stream line sources and line sinks- Line doublets line vortices- Two dimensional image stream- Milne Thomson circle theorem- Applications of circle theorems extensions of circle theorem- theorem of blassius- Use of conformal transformation- Hydro dynamical aspects of a conformal transformation- Schwarz chistoffel transformation- Vertex rows- Single infinity row of line vortices- The karman vortex sreet.

Scope as in:

1. Text book of Fluid Dynamics- F. Chorlton.

References:

1. Hydrodynamics- Milne Thomson.
2. Fluid Mechanics- Raisinghania, S. Chand.
3. An Introduction to Fluid Dynamics- G.K. Batchets, Cambridge University Press.
4. Elementary Fluid Dynamics- D.J. Acheson, Oxford University Press.
5. A First Course in Fluid Dynamics, Cambridge University press.

Outcome:

Students successfully completing this course , we expect the following outcomes

- An understanding of fluid mechanics fundamentals, including concepts of mass and momentum conservation.
- An ability to apply the Bernoulli equation to solve problems in fluid mechanics.
- An ability to apply control volume analysis to problems in fluid mechanics.

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L	T	P	C
2	0	6	2

406- MAT LAB-II

Pre Requisites: MATLAB- I.

Objectives:

- The goal of this course is to introduce students to the fundamental concepts of Scientific Programming using MATLAB and we introduce the necessary mathematical concepts as we go.
- The course will cover the syntax and semantics of Matlab including data types, control structures, comments, variables, functions, and other abstraction mechanisms.
- Once the foundations of the language have been established students will explore different types of scientific programming problems including curve fitting, optimization, integration, differentiation, statistical analysis, ODE solving, image processing, clustering, and simulation.

UNIT-I

Curve Fitting Tool Box:- Introduction to TOOL Box- Importing the Data Sets -Viewing the Data sets - Smoothing Data- Moving Average Filtering- Low less and Less: Local Regression Smoothing- **Fitting Data: -** The Fitting Process- Parametric Fitting- Basic Assumptions about the Error.

UNIT-II

Solutions of Algebraic and Transcendental Equations Programs by Using MATLAB: Bisection Method- The Method of False Position Method- Iterative Method Newton – Raphson Method- **Solutions to System of Nonlinear equations :-** Iterative method - Picards Method- Runge-Kutta Method.

UNIT-III

Numerical Integration programs by Using MATLAB:-Trapezoidal Rule- Simpson's 1/3-rule- Simpson's 3/8-rule- **Interpolation:-**Newton's Forward and Backward Interpolation Formulas.

UNIT-IV

Ordinary Differential Equations and Symbolic Mathematics: Ordinary Differential Equation solvers- Syntax of ODE solvers and steps to use ODE solvers, **Symbolic Mathematics-** Use of Symbolic Mathematics- calculus using symbolic Mathematics – simplification functions.

UNIT- V

MATLAB Applications in Control Systems: Laplace transforms – Inverse Laplace transforms- Partial fraction expansion using MATLAB- Transfer function representation- State space representation of dynamic systems- Transfer function to state space conversion and vice versa- Series/ cascade, parallel and feedback connections- time response of control systems- Standard input test signals- Step response of linear dynamic systems- Performance indices- Impulse and ramp response of control systems- Response to arbitrary input- Steady state errors- - Steady state errors for different types of inputs and systems- Stability of control systems- Routh Hurwitz criterion.

Scope as in:
1. MATLAB and Its Application In Engineering- Rajkumar Banasal, Ashok Kumar Geol-Manoj Kumar Sharma -Pearson Publications.

References:
1. Numerical Methods using MATLAB- John H.Mathews, D.fink, PHI publication.

Outcome:
Students who successfully complete this course will:

- Become familiar with general concepts in computer science
- Gain an understanding of the general concepts of programming
- Obtain a solid foundation in the use of MATLAB

Lab Practice:-

1. Write a program for Bisection method.
2. Write a program for Newton Raphson method
3. Write a program for Regula Falsi method
4. Write a program for Runge kutta method.
5. Write a program for Simpson's 1/3 rule
6. Write a program for Simpson's 3/8 rule
7. Write a program for Trapezoidal Method.
8. Write a program for Legranges Interpolation.
9. Write a program for Newton forward Interpolation.
10. Write a program for Newton backward Interpolation.
11. Write a program to implement logic gates.
12. Write a program to solve explicit ODE.
13. Write a program to solve implicit ODE.
14. Write a program to solve Boundary Value Problem (BVP).
15. Write a program to solve Delay Differential Equation (DDE).
16. Write a program to solve Partial Differential Equation (PDE).
17. Write a program to implement Unit Step Response and Unit Ramp Response.
    Eg: $\frac{0.5151z^{-1}-0.1452z^{-2}-0.2963z^{-3}+0.5528z^{-4}}{1-1.8528z^{-1}+1.5906z^{-2}-0.6642z^{-3}+0.0528z^{-4}}$
18. Write a program to find inverse Z Transform of the given function.
    Eg: $\frac{0.4637\mathrm{z}^{-1}-0.3393\mathrm{z}^{-2}}{1-1.5927\mathrm{z}^{-1}+0.6607\mathrm{z}^{-2}}$
19. Write a program to generate Fibonacci Series.
20. Write a program to implement Unit Step response in Laplace Transform for Different Problems.