**NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI - 620 015**

**DEPARTMENT OF MATHEMATICS**

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| **COURSE OUTLINE TEMPLATE** | | | | | | |
| Course Title | **TRANSFORMS, SPECIAL FUNCTIONS AND PARTIAL DIFFERENTIAL EQUATIONS** | | | | | |
| Course Code | **MAIR31** | No. of Credits | | | **3** | |
| Department | **Mathematics** | Section | | | **B.Tech Chemical (Semester- III )** | |
| Pre-requisites Course Code | **MAIR11, MAIR21** | | | | | |
| Faculty | **Dr. T.N. Janakiraman** | | Course Coordinator(s)  (if, applicable) | | | **NIL** |
| Other Course Teacher(s) / Tutor(s) E-mail | **janaki@nitt.edu** | | Mobile No. | | | **9894794198** |
| Course Type | **Core course** | | | | | |
| **COURSE OVERVIEW** | | | | | | |
| * **To have general awareness and understanding of**  1. **Various formulas involved in Laplace transforms of several functions in view of solving differential and integral equations.** 2. **Z-transforms of various functions, Fourier series and convolution theorem.** 3. **Bessel Functions and Legendre polynomials.**  * **To understand and obtain various solutions of PDEs with applications.** | | | | | | |
| **COURSE OBJECTIVES** | | | | | | |
| **Learning Objectives: Objective of the course is to introduce**   1. **Laplace Transforms and its applications to solve mathematical problems.** 2. **Z-transforms and its applications to solve difference equations.** 3. **Fourier series, Special functions and its properties.** 4. **Partial differential equations and method to solve them.** 5. **Mathematical model of one/two dimensional heat flow problems.** | | | | | | |
| **COURSE OUTCOMES (CO)** | | | | | | |
| **Course Outcomes** | | | | **Aligned Programme Outcomes(PO)** | | |
| 1. Understanding and applying the methodologies to  solve the ordinary differential equations(ODEs),  simultaneous equations with constant coefficients  and integral equations using Laplace transforms. | | | |  | | |
| 2. Understanding the basic concepts of Z-Transforms-  Solution of difference equation using Z-Transforms -  Fourier Series- Half range Fourier cosine and sine series,  Parseval’s relation.  3. Understanding the basic concepts of Bessel’s  equation, Bessel functions- Legendre’s equation-  Legendre polynomials.  4. Understanding the basic concepts of forming partial  differential equations by eliminating arbitrary constants  and functions – solution of first order equations – four  standard types – Lagrange’s equation – homogeneous  and non – homogeneous types of second order linear  differential equation with constant coefficients.  5. Understanding the Applications of Partial Differential  Equations – Solution of one - dimensional heat flow  equation and two dimensional heat flow equation -  method of separation of variables using Fourier series. | | | | The engineering under- graduates will apply their knowledge of Transforms, special functions and Partial differential Equations techniques to solve industrially applicable problems. | | |
| **MAIR31 - TRANSFORMS, SPECIAL FUNCTIONS AND PARTIAL DIFFERENTIAL EQUATIONS**  Laplace Transforms of standard functions – derivatives and integrals - Inverse Laplace Transform - Convolution theorem – Periodic functions - Application to ordinary differential equations and simultaneous equations with constant coefficients and integral equations.  Z-Transforms- inverse Z-transforms- Solution of difference equation with constant coefficients using Z-transforms- Fourier series - Dirichiet conditions – Half range Fourier cosine and sine series - Parseval's relation.  Bessel’s Equation- Bessel Functions- Recurrence relations- Generating functions for Bessel functions- Legendre’s equation- Legendre polynomials- Rodrigue’s formula- Generating function and recurrence relations for Legendre polynomials- Orthogonality property of Legendre polynomials.  Formation of partial differential equations eliminating arbitrary constants and functions - Solution of first order equations - four standard types - Lagrange's equation - homogeneous and non-homogeneous type of second order linear differential equations with constant coefficients.  Applications of Partial Differential Equations- Solutions of one-dimensional heat flow equation and two-dimensional heat flow equation (Cartesian and Polar form) in steady state by the method separation of variables using Fourier series. | | | | | | |

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| **COURSE TEACHING AND LEARNING ACTIVITIES** | | | | | | | |
| **S.No.** | **Week** | | **Topic** | | | | **Mode of Delivery** |
| **1.**  **2.**  **3.**  **4.**  **5.**  **6.**  **7.**  **8.**  **9.**  **10.**  **11.**  **12.**  **13.**  **14.** | **Week- 1**  **Week- 2**  **Week- 3**  **Week- 4**  **Week- 5**  **Week- 6**  **Week- 7**  **Week- 8**  **Week- 9**  **Week- 10**  **Week- 11**  **Week- 12**  **Week- 13**  **Week- 14** | | **Introduction to Laplace transform(LT) and**  **its applications, Definition, Existence of**  **Laplace transform, Examples, Properties of**  **LT, LT of some functions, First translation**  **theorem and inverse LT of some functions.**  **Derivatives and Integrals of LT, Convolution theorem-statement and proof, LT of periodic functions, LT of derivatives of f(t).**  **Solutions of ordinary differential equations, simultaneous differential equations and integral equations by using Laplace transform.**  **Introduction to Z-Transforms and inverse Z-transforms, Examples, Properties of ZT, ZT of some functions.**  **Solutions of difference equation with constant coefficients using Z-transforms. Fourier series – Importance and applications of Fourier series in technology.**  **Fourier expansion for different functions. Dirichlet’s conditions. Half range Fourier cosine and sine series- Series expansion for odd and even functions.**  **Parseval’s relation. Problems using Parseval identity. Introduction to Bessel’s equation and Bessel functions. Recurrence relations.**    **Generating functions for Bessel functions. Legendre’s equation. Legendre polynomials.**  **Rodrigue’s formula. Generating functions and recurrence relations for Legendre polynomials.**   1. **Orthogonality property of Legendre polynomials. Convolution theorem. Convolution**   **product of functions. Problem using**  **convolution theorem.**  **Formation of partial differential equations by eliminating arbitrary constants and functions.**  **Solution of first order equations – four standard types – Lagrange’s equation.**  **Solution of homogeneous and non –homogeneous types of second order linear differential equation with constant coefficients.**  **Applications of Partial Differential Equations.**  **Solution of one - dimensional heat flow equation and two dimensional heat flow equation - method of separation of variables using Fourier series.** | | | | **Chalk and Talk**  **Chalk and Talk** |
| **COURSE ASSESSMENT METHODS** | | | | | | | |
| **S.No.** | | **Plan** | | **Week/Date** | **Duration** | **% Weightage** | |
| **1.**  **2.**  **3.**  **4.**  **5.** | | **Assessment – I**  **Assessment - II**  **Assessment - III**  **Two Assignments**  **(each covering two units with five marks weightage)**  **End Semester Exam** | | **7th week**  **13th week**  **15th or 16th week** | **1 and 1/2 Hour**  **1 and 1/2 Hour**  **1 and 1/2 Hour**  **3 Hours** | **20%**  **20%**  **20%**  **10%**  **50% Total : 100 Marks** | |
| **ESSENTIAL READINGS : Textbooks, reference books Website addresses, journals, etc** | | | | | | | |
| ***Reference Books:***   1. **Sneddon, I. N., “Elements of Partial Differential Equations”, Courier Corporation, 2013.** 2. **Grewal, B.S., Higher Engineering Mathematics, 43rd edition, Khanna Publications, Delhi.** 3. **Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2010.** 4. **K.Sankara Rao, Introduction to Partial Differential Equations, 3rd Edition, PHI Learning Private Ltd. 2012.** 5. **Debnath L., and Dambaru Bhatta, Integral Transforms and Their Applications, 2nd Ed. (Special Indian Ed).Chapman & Hall/CRC, Indian Edition, 2010.** | | | | | | | |
| **COURSE EXIT SURVEY (mention the ways in which the feedback about the course is assessed and indicate the attainment also)** | | | | | | | |
| **1. Feedback from students during class committee meeting.**  **2. Anonymous feedback through questionnaire (as followed previously).** | | | | | | | |
| **COURSE POLICY (including plagiarism, academic honesty, attendance, etc.)**  **1. Examination**:  **a)** Students who have missed the first or second Assessment test or both can register  for Assessment - III examination which shall be conducted soon after the completion of the  second Assesment test and before the regular semester examination.    **b)** The Assessment - III examination shall be conducted for 20 marks comprising the syllabus  of both first and second Assesment tests.    **c)** Students should submit the assignments before the last date of submission. In case  students fails to submit their assignments, he/she will get zero mark for that  particular assignment.  **2. Attendance**:  a) The minimum attendance for appearing for the semester examination is 75%.  b) Those students, whose attendance falls below 75% but above 50% in a subject,  shall attend mandatory classes before the semester examinations to qualify to  write semester exam.  c)The students who are having attendance less than or equal to 50% has to redo the  course.  **3.** The Institute follows relative grading with flexibility given to teachers to decide the  mark ranges for grades. All assessment of a course will be done on the basis of  marks.  **4.** The Performance Analysis Committee, which shall meet within couple of weeks after  the completion of all examinations, shall analyze the relative cumulative  performance of students in all examinations (continuous and end-semester) of a  course and finalize the letter grade ranges for the course.  **5.** The letter grades and the corresponding grade points are as follows:     |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Letter** | **S** | **A** | **B** | **C** | **D** | **E, R** | **F, I** | **V** | **FF** | **X** | | **Grade(GP)** | **10** | **9** | **8** | **7** | **6** | **5** | **0** | **-** | **2** | **-** |   a) Students scoring less than the passing minimum marks in the assessments defined  in the course plan shall be deemed to have not successfully completed the course  and be given an ‘F’ grade.  b) Students awarded F grade may REDO the course or opt for formative assessment.  c) ‘V’ indicates lack of required attendance. Students awarded ‘V’ grade must | | | | | | | |