**University of Asia Pacific (UAP)**

**Department of Basic Sciences & Humanities**

**Course Outline**

**Program:** Computer Science & Engineering (CSE)

**Course Title:** Math IV: Differential Equations and Laplace and

Fourier Transformation

**Course Code:** MTH 205

**Semester:** Fall-2019

**Level:** 2nd year 2nd Semester

**Credit Hour:** 3.0

**Name & Designation of Teacher:** Sk. Reza-E-Rabbi, Lecturer, Department of BS&H

**Office/Room:** Department of BS&H, 2nd floor, UAP campus

**Class Hours:**  Section A: Sunday-2.00 P.M-3.20 P.M,

Tuesday -2.00 P.M- 3.20 P.M

Section B: Monday-11.00 A.M-12.30 P.M,

Wednesday -12.30 P.M-1.50 P.M

**Consultation Hours:** Sunday: 12:30 pm-1:00 pm & 3:30pm-4:00pm

Monday: 3:30pm-4:00pm

Tuesday: 12:30 pm-1:00 pm & 3:30pm-4:00pm

Wednesday: 3:30pm-4:00pm

Thursday: 12:30 pm-1:00 pm

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**Rationale:** Ordinary differential equation is required for the students to be able to build up mathematical models to solve different physical problems described by differential equations and able to analyze them.

**Pre-requisite** (if any)**:** MTH 201

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| **Course Synopsis:** | **First Order Differential Equations:** Linear Equations, Separable Equations, Exact Equations, Bernoulli Differential Equations, Substitutions, Intervals of Validity, Modeling with First Order Differential Equations, Equilibrium Solutions, Euler’s Method.  **Laplace Transforms:** Laplace Transforms, Inverse Laplace Transforms, Step Functions, Solving Initial Value Problems with Laplace Transforms.  **Systems of Differential Equations:** Second Order Equations and Systems, Euler's Method for Systems, Qualitative Analysis, Linear Systems (Vector Representations of Solutions of Linear Systems, Eigen values and Eigenvectors Technique, Qualitative Analysis of Linear Systems), Nonlinear Systems (Equilibrium Point Analysis: Linearization Technique).  **Series Solutions:** Series Solutions, Euler Equations.  **Higher Order Differential Equations:** Basic Concepts for nth Order Linear Equations, Linear Homogeneous Differential Equations, Undetermined Coefficients, Variation of Parameters, Laplace Transforms, Systems of Differential Equations, Series Solutions.  **Boundary Value Problems & Fourier Series:** Boundary Value Problems, Eigen values and Eigen functions, Periodic Functions and Orthogonal Functions, Fourier Sine Series, Fourier Cosine Series, Fourier Series, Convergence of Fourier Series.  **Partial Differential Equations:** The Heat Equation, The Wave Equation, Terminology, Separation of Variables, Solving the Heat Equation, Heat Equation with Non-Zero Temperature Boundaries, Laplace’s Equation, Vibrating String. |

**Course Objectives (CO):** The objectives of this course are

1. To apply appropriate methods to find the solutions of first order differential equations, systems of differential equations, series solutions, higher order differential equations and partial differential equations.
2. To explain the Laplace transform and inverse Laplace transforms of standard functions both from the definition and by using tables. Application based problems of ODE using Laplace and inverse Laplace transforms.
3. To introduce periodic function, odd and even function. Apply Fourier analysis to simple initial condition standing wave problems.

**Learning Outcomes (LO):** After completion of the course student will be able to

1. Recognize and solve first order differential equations and higher order differential equations by using various methods with and without initial conditions.
2. Find the solution of partial differential equations and series solution.
3. Determine Laplace transforms and inverse Laplace transforms of various functions. Use the method of Laplace transforms to solve initial-value problems and boundary value problems for linear differential equations with constant coefficients.
4. Understand the nature of the Fourier series that represent even and odd functions as a half-range cosine or sine Fourier Series and how derivation of a Fourier series can be simplified in this way.

**Teaching-learning and Assessment Strategy:** Lectures, assignments, quizzes, exams

**Linkage of LO with Assessment Methods & their Weights:**

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| **LO** | **Assessment Method** | **(%)** |
| 1 – 4 | Quiz | 20 |
| 1 – 4 | Class attendance | 10 |
| 1, 2 | Midterm Exam | 20 |
| 1 – 4 | Final Exam | 50 |

**Minimum attendance:** 70% class attendance is mandatory for a student in order to appear at the final examination.

**Mapping of Course LO and Generic Skills:**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Learning Outcome (LO) of the Course** | **Generic Skills\* (Appendix-1)** | | | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Recognize and solve first order differential equations and higher order differential equations by using various methods with and without initial conditions. | √ | √ | √ |  |  |  |  |  |  |  |
| Find the solution of partial differential equations and series solution. | √ | √ |  |  |  |  |  |  |  |  |
| Determine Laplace transforms and inverse Laplace transforms of various functions. Use the method of Laplace transforms to solve initial-value problems and boundary value problems for linear differential equations with constant coefficients. | √ | √ | √ |  |  |  |  |  |  |  |
| Understand the nature of the Fourier series that represent even and odd functions as a half-range cosine or sine Fourier Series and how derivation of a Fourier series can be simplified in this way. | √ | √ | √ |  |  |  |  |  |  |  |

**Lecture Schedule**

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| **Weeks** | **Topics** | **Reading Materials** |
| 1 | Definition and formulation of differential equation | Ordinary and Partial Differential Equation by M. D. Raisinghania  &  HK Dass, Advanced Engineering Mathematics |
| 2-3 | Solution of first order ordinary differential equations by various methods | Ordinary and Partial Differential Equation by M. D. Raisinghania  &  HK Dass, Advanced Engineering Mathematics |
|  | **QUIZ 1** |  |
| 4 | Solution of ordinary differential equations of first order and higher degree | Ordinary and Partial Differential Equation by M. D. Raisinghania  &  Hk Dass, Advanced engineering Mathematics |
| 5 | Solution of general linear equations of second and higher orders with constant coefficient | Ordinary and Partial Differential Equation by M. D. Raisinghania  &  Hk Dass, Advanced engineering Mathematics |
|  | **QUIZ 2** |  |
| 6 | Solution of Euler’s homogenous linear equations | Ordinary and Partial Differential Equation by M. D. Raisinghania  &  HK Dass, Advanced Engineering Mathematics |
| 7 | Partial Differential Equation | Ordinary and Partial Differential Equation by M. D. Raisinghania  &  HK Dass, Advanced engineering Mathematics |
| 8 | Review of Midterm Syllabus |  |
|  | **MIDTERM EXAM** |  |
| 9 | Definition, Laplace transforms of some elementary functions, Sufficient conditions for existence of Laplace transforms, the unit step function, Periodic functions | Schaum’s Outline of Laplace Transforms by Murray R. Spiegel  &  Professor Md. Abdur Rahman, Mathematical Methods, Vol: 1 & 2 |
|  | **QUIZ 3** |  |
| 10 | Inverse Laplace transforms, some special theorems on Laplace transforms, partial fraction | Schaum’s Outline of Laplace Transforms by Murray R. Spiegel  &  Professor Md. Abdur Rahman, Mathematical Methods, Vol: 1 & 2 |
| 11 | Laplace transforms of derivatives, Evolution of integral, Solutions of differential equations by Laplace transformations | Schaum’s Outline of Laplace Transforms by Murray R. Spiegel  &  Professor Md. Abdur Rahman, Mathematical Methods, Vol: 1 & 2 |
|  | **QUIZ 4** |  |
| 12 | Real and Complex form finite transform | Schaum’s Outline of Laplace Transforms by Murray R. Spiegel  &  Professor Md. Abdur Rahman, Mathematical Methods, Vol: 1 & 2 |
| 13 | Fourier integral, Fourier transforms and their uses in solving Boundary value problem | Schaum’s Outline of Laplace Transforms by Murray R. Spiegel  &  Professor Md. Abdur Rahman, Mathematical Methods, Vol: 1 & 2 |
| 14 | Review of Final Exam Syllabus |  |
|  | **FINAL EXAM** |  |

**Required Reference(s):**

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|  | 1. M.D. Raisinghania, Ordinary and Partial Differential Equation (Revised Edition) 2. HK Dass, Advanced Engineering Mathematics. 3. Murray R. Spiegel, Schaum’s Outline of Theory and Problems of Laplace Transforms. 4. Professor Md. Abdur Rahman, Mathematical Methods, Vol: 1 & 2. |

**Recommended Reference(s):** Dennis G. Zill, A First course in Differential Equations with Modeling Applications (7th Edition)

**Grading System:** As per the approved grading scale of University of Asia Pacific (Appendix-2).

**Student’s responsibilities:** Students must come to the class prepared for the course material covered in the previous class(es).

They must submit their assignments on time.

They must be aware of the *Plagiarism Policy* as spelt out in the curriculum.

No late or partial assignments will be acceptable. There will be no make-up quizzes

**Appendix-1: Generic Skills**

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| **No.** | **Generic Skills** |
|  |  |
| 1. | Engineering Knowledge |
| 2. | Problem Analysis |
| 3. | Design/Development of Solutions |
| 4. | Investigation |
| 5. | Modern Tool Usage |
| 6. | The Engineer and Society |
| 7. | Environment and Sustainability |
| 8. | Ethics |
| 9. | Communication |
| 10. | Individual and Team Work |
| 11. | Life Long Learning |
| 12. | Project Management and Finance |

**Generic Skills (Detailed):**

1. **Engineering Knowledge (T)** -Apply knowledge of mathematics, sciences, engineering fundamentals and manufacturing engineering to the solution of complex engineering problems;
2. **Problem Analysis (T)** – Identify, formulate, research relevant literature and analyze complex engineering problems, and reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences;
3. **Design/Development of Solutions (A)** –Design solutions, exhibiting innovativeness, for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, economical, ethical, environmental and sustainability issues.
4. **Investigation (D)** Conduct investigation into complex problems, displaying creativeness, using research-based knowledge, and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions;
5. **Modern Tool Usage (A & D)** -Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations;
6. **The Engineer and Society (ESSE)** -Apply reasoning based on contextual knowledge to assess societal, health, safety, legal, cultural, contemporary issues, and the consequent responsibilities relevant to professional engineering practices.
7. **Environment and Sustainability (ESSE)** -Understand the impact of professional engineering solutions in societal, global, and environmental contexts and demonstrate knowledge of and need for sustainable development;
8. **Ethics (ESSE)** –Apply professional ethics with Islamic values and commit to responsibilities and norms of professional engineering code of practices.
9. **Communication (S)** -Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions;
10. **Individual and Team Work (S)** -Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
11. **Life Long Learning (S)** -Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
12. **Project Management and Finance (S)** -Demonstrate knowledge and understanding of engineering management and financial principles and apply these to one’s own work, as a member and/or leader in a team, to manage projects in multidisciplinary settings, and identify opportunities of entrepreneurship.

**Appendix-2: Grading Policy**

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| **Numeric Grade** | **Letter Grade** | **Grade Point** |
|  |  |  |
| 80% and above | A+ | 4.00 |
| 75% to less than 80% | A | 3.75 |
| 70% to less than 75% | A- | 3.50 |
| 65% to less than 70% | B+ | 3.25 |
| 60% to less than 65% | B | 3.00 |
| 55% to less than 60% | B- | 2.75 |
| 50% to less than 55% | C+ | 2.50 |
| 45% to less than 50% | C | 2.25 |
| 40% to less than 45% | D | 2.00 |
| Less than 40% | F | 0.00 |

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| **Prepared by:**  **----------------------------------** | **Checked by:**  **-----------------------------** | **Approved by: (Head of the Dept.)**  **-----------------------------** |