# Course Specification

(Postgraduate)

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| Course Title: **Perturbation Theory** |
| Course Code:**MATH658** |
| Program: **Master Program in Mathematics** |
| Department: **Mathematics** |
| College: **Science** |
| Institution: **University of Tabuk, KSA** |
| Version: **2** |
| Last Revision Date:**1/12/1443 H** |

## Table of Contents

# A. General information about the course:

| Course Identification | | | | | |
|---|---|---|---|---|---|
| **1. Credit hours:** | 3 H | | | | |
| **2. Course type** | | | | | |
| a. | University ☐ | College ☐ | Department☒ | Track☐ | Others☐ |
| b. | Required ☐ | Elective☒ | | | |
| **3. Level/year at which this course is offered:** Level-2 or higher | | | | | |
| **4. Course general Description**<br><br>Perturbation theory is used to solve the nonlinear differential equations having no exact or problematic solutions. In fluid mechanics, perturbation theory is applied to solve airfoil and wing aerodynamics as well as high and low Reynolds number flow. It is expected the students are familiar with this mathematical tool in this course and they can apply different methods to solve a regular or singular perturbation equation | | | | | |
| **5. Pre-requirements for this course (if any):** None | | | | | |
| **6. Co- requirements for this course (if any):** None | | | | | |
| **7. Course Main Objective(s)**<br>1. Solve the nonlinear differential equations having no exact or problematic solutions.<br>2. Applications on fluid mechanics and applied to solve airfoil and wing aerodynamics as well as high and low Reynolds number flow.<br>3. Applications of different methods to solve a regular or singular perturbation equation | | | | | |

## 1. Teaching mode(mark all that apply)

| No | Mode of Instruction | Contact Hours | Percentage |
|---|---|---|---|
| 1. | Traditional classroom | 45 | 100 % |
| 2. | E-learning | | |
| 3. | Hybrid<br>● Traditional classroom<br>● E-learning | | |
| 4. | Distance learning | | |

## 2. Contact Hours (based on the academic semester)

| No | Activity | Contact Hours |
|---|---|---|
| 1. | Lectures | 3 H /week |

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|---|---|---|
| 2. | Laboratory/Studio | |
| 3. | Field | |
| 4. | Tutorial | |
| 5. | Others (specify) | |
| | Total | 40 |

## B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

| Code | Course Learning Outcomes | Code of CLOs aligned with program | Teaching Strategies | Assessment Methods |
|---|---|---|---|---|
| 1.0 | Knowledge and understanding<br>The students will be able to: | | | |
| 1.1 | Demonstrate the advanced concepts of differential and partial differential equations. | K1 | Lectures, Group works, Presentations, Classroom discussion, Seminar, Case study, problem solving session | Exams, Quizzes, Research project, presentation, interactive discussion and participation, Surveys. |
| 1.2 | Describe the advanced methods to solve the linear and non-linear differential and partial differential equation problems. | K2 | | |
| 1.3 | Describe the analytical methods to solve the initial and boundary value problems to get the desired results. | K2 | | |
| 2.0 | Skills<br>The students will be able to: | | | |
| 2.1 | Apply the concept of perturbation theory in solving the linear and non-linear differential and partial differential equations. | S1 | Lectures, Group works, Presentations, Classroom discussion, Seminar, Case study, problem solving session | Exams, Quizzes, Home works, Assignments, Research project, presentation, interactive discussion and participation, Surveys. |
| 2.2 | Analyze the right analytical method to find the solution of problems. | S2 | | |
| 2.3 | Solving complex mathematical problems in perturbation theory. | S2 | | |
| 3.0 | Values, autonomy, and responsibility<br>The students will be able to: | | | |

| Code | Course Learning Outcomes | Code of CLOs aligned with program | Teaching Strategies | Assessment Methods |
|---|---|---|---|---|
| 3.1 | Demonstrate responsibly to solve problems on time. | V2 | Lectures, Group works, Presentations, Classroom discussion, Seminar, Case study, problem solving session | Research project, Home works, Assignments, presentation, interactive discussion and participation, Surveys. |
| 3.2 | Demonstrate the responsibility to work independently. | V2 | | |

## C. Course Content

| No | List of Topics | Contact Hours |
|---|---|---|
| 1 | A short review on the solution of differential equations. | 3 |
| 2 | Asymptotic definitions | 3 |
| 3 | Uniformity & non-uniformity, Regular Perturbation: Algebraic equation, Expansion method. | 3 |
| 4 | Transcendental and Differential equations., | 3 |
| 5 | Singular Perturbation-Examples. | 3 |
| 6 | Infinite domain Multiply of ‘e’ to the highest derivative | 3 |
| 7 | **Mid-Exam #** | --- |
| 7 | Type change of partial differential equation, | 3 |
| 8 | Invalid equations in singular regions. | 3 |
| 9 | Singularity removal | 3 |
| 10 | The method of strained coordinates | 3 |
| 11 | Light hill’s technique. | 3 |
| 12 | Temple’s Technique, Renormalization technique. | 3 |
| 13 | The method of Matched Asymptotic Expansion | 3 |
| 14 | Prandtl’s Technique, Van Dyke’s Technique | 3 |
| 15 | The method of multiple scales: Method descriptions, the two variable expansion | 3 |

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| | procedure. | |
| 16+17 | **Revision & Final Exam** | |
| **Total** | | **45** |

## D. Students Assessment Activities

| No | Assessment Activities * | Assessment timing (in week no) | Percentage of Total Assessment Score |
|---|---|---|---|
| 1. | Home works and Assignments | Weekly basis | 20% |
| 2. | Mid-term exam | 7th week | 25% |
| 3. | Presentation and discussion | During the Semester | 15% |
| 4. | Final Exam | At End of Semester | 40 % |

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.)

## E. Learning Resources and Facilities

### 1. References and Learning Resources

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|---|---|
| Essential References | 1. Reza N. Jazar , Perturbation Methods in Science and Engineering, Springer International Publishing (2021) |
| Supportive References | 2. Bhimsen Shivamoggi , Perturbation Methods for Differential Equations, Birkhäuser Boston (2012). |
| Electronic Materials | Saudi digital library |
| Other Learning Materials | None |

### 2. Required Facilities and equipment

| Items | Resources |
|---|---|
| facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.) | Lecture Room with capacity of 30 students and equipped with White Board, Library |
| Technology equipment (projector, smart board, software) | Overhead projector and internet connection. |
| Other equipment (depending on the nature of the specialty) | None |

## F. Assessment of Course Quality

| Assessment Areas/Issues | Assessor | Assessment Methods |
|---|---|---|
| Effectiveness of teaching | Students | Direct and Indirect |
| Effectiveness of students assessment | Teacher | Direct |
| Quality of learning resources | Students | Indirect |
| The extent to which CLOs have been achieved | Teacher, Quality Committee | Direct and Indirect |
| Other | | |

**Assessor** (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

**Assessment Methods**(Direct, Indirect)

## G. Specification Approval Data

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| **Council / Committee** | **Approval by the Department Council** |
| **Reference No.** | DEPARTMENT COUNCIL NO (26) |
| **Date** | **11/9/1444 H** |