Kingdom of Saudi Arabia
National Commission for
Academic Accreditation & Assessment

المملكـة العربيـة السعوديـة
الهيئـــة الوطنيـــة للتقويـم
والاعـتـمـاد الأكـاديـمـي

كلية العلوم التطبيقية
Faculty of Applied Sciences

**Kingdom of Saudi Arabia**
**The National Commission for Academic Accreditation & Assessment**

# T6. Course Specifications (CS)

## Course title: Theoretical Methods in Physics (2)

## Course code: 23063242-4

# Course Specifications

| | |
|---|---|
| Institution: **Umm AL – Qura University** | Date : **11/3/1439** |
| College/Department : **Jamoum University College – Physics Department** | |

## A. Course Identification and General Information

1. Course title and code: **Theoretical Methods in Physics (2) 23063242-4**
2. Credit hours: **4 hrs.**
3. Program(s) in which the course is offered. **BSc Physics.**
(If general elective available in many programs indicate this rather than list programs)
4. Name of faculty member responsible for the course
**One of the staff members**
5. Level/year at which this course is offered : **3rd Year / Level 5**
6. Pre-requisites for this course (if any) : **Theoretical Methods in Physics 23062241-4**
7. Co-requisites for this course (if any) : ---
8. Location if not on main campus: **Al-Jamoum**
9. Mode of Instruction (mark all that apply)

| | | | |
|---|---|---|---|
| a. traditional classroom | ✓ | What percentage? | **100%** |
| b. blended (traditional and online) | | What percentage? | |
| c. e-learning | | What percentage? | |
| d. correspondence | | What percentage? | |
| f. other | | What percentage? | |

Comments:

## B Objectives

1. What is the main purpose for this course?

This course is designed to supply students for a variety of mathematical methods that need for advanced undergraduate and beginning graduate study in physical science and to develop a solid background for those who will continue into the mathematics of advanced theoretical physics.

2. Briefly describe any plans for developing and improving the course that are being implemented. (e.g. increased use of IT or web based reference material, changes in content as a result of new research in the field)

1. Deal with special functions (factorial, gamma, beta and error functions) that are used extensively in physics problems.
2. Use Legendre function, Bessel equation, and Laguerre function as solutions of some types of differential equations
3. Be familiar with the methods of solving partial differential equations (PDE).
4. Translate a physical problem in mathematical form (PDE, boundary value problem).
5. Deal with Functions of a complex variable, and contour integrals, and use them to find residues and to calculate definite integrals.
6. Develop an intuitive feeling for the precise mathematical formulation of physical problems and for the physical interpretation of the mathematical solutions.
7. Be familiar with the mathematical formulae of this course that frequently appear in physics problems.
8. Use computer to verify the solution of some physical problems.
9. Use computer to construct graphs of some functions.

## C. Course Description (Note: General description in the form used in Bulletin or handbook)

Course Description:

The objective of this course is to learn in a practical manner the mathematical techniques and methods useful in physical sciences, not covered by previous courses (Theoretical Methods in Physics (1)**)**. The approach requires a combination of mathematics, skill in making legitimate approximations, and intelligent use of computers to get some motivation and verify the approximations. The course is designed to supply students for a variety of mathematical methods that need for advanced undergraduate and beginning graduate study in physical science and to develop a solid background for those who will continue into the mathematics of advanced theoretical physics.

### 1 Topics to be Covered

| Topics | No of Weeks | Contact hours |
|---|---|---|
| ❖ **Special functions:** Factorial Function, Gamma Function; Recursion Relation, Some Important Formulas Involving Gamma Functions, Beta Functions, Beta Functions in Terms of Gamma Functions, The Error | **2** | **8** |

| | | |
|---|---|---|
| Function, Asymptotic Series, Stirling's Formula, Elliptic Integrals and Functions. | | |
| ❖ **Legendre's functions:** Leibniz' Rule, Rodrigues' Formula, Generating Function, Orthogonality of the Legendre Polynomials, Normalization of the Legendre Polynomials, Legendre Series, Associated Legendre Functions, Generalized Power Series. | **2.5** | **10** |
| ❖ **Bessel's functions:** First and Second Solution of Bessel's Equation, Graphs and Zeros of Bessel Functions, Recursion Relations, Other Kinds of Bessel Functions, Orthogonality of Bessel Functions. | **2.5** | **10** |
| ❖ **Hermite - Laguerre Functions:** Ladder operators, Hermite functions, Hermite polynomials, Laguerre functions, Laguerre polynomials, Associated Laguerre polynomials. | **2** | **8** |
| ❖ **Partial Differential Equations:** Laplace's Equation; Steady-State Temperature in a Rectangular Plate, The Diffusion or Heat Flow Equation, The Wave Equation; the Vibrating String, Steady-state Temperature in a Cylinder, Steady-state Temperature in a Sphere, Poisson's Equation Integral Transform Solutions of Partial Differential Equations | **2** | **8** |
| ❖ **Functions of a complex variable:** Analytic functions- Cauchy-Riemann conditions, Contour Integrals, Laurent Series, The residue theorem, Methods of finding the residues, Evaluation of Definite Integrals, Mapping. | **3** | **12** |
| | **14 weeks** | **56 hrs** |

2. Course components (total contact hours and credits per semester):

| | Lecture | Tutorial | Laboratory or Studio | Practical | Other: | Total |
|---|---|---|---|---|---|---|
| Contact Hours | **56** | | **--** | | | **56** |
| Credit | **4** | | **--** | | | |

3. Additional private study/learning hours expected for students per week. 4

## 4. Course Learning Outcomes in NQF Domains of Learning and Alignment with Assessment Methods and Teaching Strategy

On the table below are the five NQF Learning Domains, numbered in the left column.
**First**, insert the suitable and measurable course learning outcomes required in the appropriate learning domains (see suggestions below the table).
**Second**, insert supporting teaching strategies that fit and align with the assessment methods and intended learning outcomes.
**Third**, insert appropriate assessment methods that accurately measure and evaluate the learning outcome. Each course learning outcomes, assessment method, and teaching strategy ought to reasonably fit and flow together as an integrated learning and teaching process. (Courses are not required to include learning outcomes from each domain.)

| Code # | NQF Learning Domains And Course Learning Outcomes | Course Teaching Strategies | Course Assessment Methods |
|---|---|---|---|
| **1.0** | **Knowledge** | | |
| 1.1 | Define the physical quantities, physical phenomena, and basic principles. | 1- Demonstrating the basic principles through lectures.<br>2. Discussing phenomena with illustrating pictures and diagrams.<br>3. Lecturing method: Board, Power point.<br>4. Discussions<br>5. Brain storming<br>6. Start each chapter by general idea and the benefit of it. | Solve some example during the lecture.<br>Discussions during the lectures<br>Exams:<br>a) Quizzes (E-learning)<br>b) Short exams (mid- term exams)<br>c) Long exams (final)<br>d) Oral exams<br>. |
| 1.2 | Describe the physical laws and quantities using mathematics | | |
| **2.0** | **Cognitive Skills** | | |
| 2.1 | Apply the laws of physics to calculate some quantities. | 1. Preparing main outlines for teaching.<br>2. Following some proofs.<br>3. Define duties for each chapter<br>4. Encourage the student to look for the information in different references. | 1. Exams (Midterm, final, quizzes)<br>2. Asking about physical laws previously taught<br>3. Writing reports on selected parts of the course. |
| 2.2 | Solve problems in physics by using suitable mathematics. | | |
| 2.3 | Analyse and interpret quantitative results. | | |
| 2.4 | Apply physical principle on day life phenomena. | | |

| | | | |
|---|---|---|---|
| 2.5 | Derive the physical laws and formulas. | 5. Ask the student to attend lectures for practice solving problem. | 4. Discussions of how to simplify or analyze some phenomena. |
| **3.0** | **Interpersonal Skills & Responsibility** | | |
| 3.1 | Show responsibility for self-learning to be aware with recent developments in physics | • Search through the internet and the library.<br>• Small group discussion.<br>• Enhance self-learning skills.<br>• Develop their interest in Science through : (lab work, visits to scientific and research institutes). | • Evaluate the efforts of each student in preparing the report.<br>• Evaluate the scientific reports.<br>• Evaluate the team work in lab and small groups.<br>• Evaluation of students presentations. |
| 3.2 | Work effectively in groups and exercise leadership when appropriate. | | |
| **4.0** | **Communication, Information Technology, Numerical** | | |
| 4.1 | Communicate effectively in oral and written form. | • Incorporating the use and utilization of computer, software, network and multimedia through courses<br>• preparing a report on some topics related to the course depending on web sites | • Evaluating the scientific reports.<br>• Evaluating activities and homework |
| 4.2 | Collect and classify the material for the course. | | |
| 4.3 | Use basic physics terminology in English. | | |
| 4.4 | Acquire the skills to use the internet communicates tools. | | |
| **5.0** | **Psychomotor (NA)** | | |

**5. Map course LOs with the program LOs. (Place course LO #s in the left column and program LO #s across the top.)**

| Course LOs # | Program Learning Outcomes (Use Program LO Code #s provided in the Program Specifications) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.1 | 1.2 | 1.3 | 2.1 | 2.2 | 2.3 | 2.4 | 2.5 | 3.1 | 3.2 | 4.1 | 4.2 | 4.3 | 4.4 | 5.1 | 5.2 |
| 1.1 | ✓ | | | | | | | | | | | | | | | |
| 1.2 | | ✓ | | | | | | | | | | | | | | |
| 1.3 | | | | | | | | | | | | | | | | |
| 2.1 | | | | ✓ | | | | | | | | | | | | |
| 2.2 | | | | | ✓ | | | | | | | | | | | |
| 2.3 | | | | | | ✓ | | | | | | | | | | |
| 2.4 | | | | | | | ✓ | | | | | | | | | |
| 2.5 | | | | | | | | ✓ | | | | | | | | |
| 3.1 | | | | | | | | | ✓ | | | | | | | |
| 3.2 | | | | | | | | | | ✓ | | | | | | |
| 4.1 | | | | | | | | | | | ✓ | | | | | |
| 4.2 | | | | | | | | | | | | ✓ | | | | |
| 4.3 | | | | | | | | | | | | | ✓ | | | |
| 4.4 | | | | | | | | | | | | | | ✓ | | |
| 5.1 | | | | | | | | | | | | | | | | |
| 5.2 | | | | | | | | | | | | | | | | |

| 6. Schedule of Assessment Tasks for Students During the Semester | | | |
|---|---|---|---|
| | Assessment task (e.g. essay, test, group project, examination, speech, oral presentation, etc.) | Week Due | Proportion of Total Assessment |
| 1 | Exercises & Home works | All weeks | 10 % |
| 2 | Participation | All weeks | 10 % |
| 3 | In-Class Problem Solving | All weeks | 10 % |
| 4 | Midterm 1 | 6th week | 10 % |
| 5 | Midterm 2 | 12th week | 10 % |
| 6 | Final Exam | 16th week | 50 % |

## D. Student Academic Counseling and Support

1. Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice. (include amount of time teaching staff are expected to be available each week)
Each student will supervise by academic adviser in physics Department and the time table for academic advice were given to the student each semester. (4hrs per week)

## E Learning Resources

1. List Required Textbooks
   1. Mary L. Boas, Mathematical methods in the Physical sciences, third edition, John Wiley and Sons (2006), ISBN-13 978-0-471-19826-0.
   2. George B. Arfken, Hans J. Weber and Frank E. Harris, Mathematical Methods for Physicists (Seventh Edition), Elsevier (2012), ISBN: 978-0-12-384654-9.
   3. G. Dennis Zill, R. Michael Cullen, Advanced engineering mathematics, Jones and Bartlett Publisher (2006), ISBN 9780763745912.
   4. Eugene Butkov, Mathematical Physics, World student series edition (1973).
   5. S. Grossman, Elementary Linear Algebra, 6th edition, Wadsworth (2006).
2. List Essential References Materials (Journals, Reports, etc.)
3. List Recommended Textbooks and Reference Material (Journals, Reports, etc)
4. List Electronic Materials, Web Sites, Facebook, Twitter, etc.
5. Other learning material such as computer-based programs/CD, professional standards or regulations and software.

## F. Facilities Required

Indicate requirements for the course including size of classrooms and laboratories (i.e. number of seats in classrooms and laboratories, extent of computer access etc.)

1. Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)
   - Class room is already provided with data show.

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|---|
| • The area of class room is suitable concerning the number of enrolled students (68) and air conditioned.<br>• Library.<br>• Laboratory for fundamental of physics. |
| 2. Computing resources (AV, data show, Smart Board, software, etc.)<br>• Computer room.<br>• MATLAB software. |
| 3. Other resources (specify, e.g. if specific laboratory equipment is required, list requirements or attach list) |

## G Course Evaluation and Improvement Processes

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|---|
| 1 Strategies for Obtaining Student Feedback on Effectiveness of Teaching<br>• Course reports<br>• Course evaluation. |
| 2 Other Strategies for Evaluation of Teaching by the Instructor or by the Department<br>• Revision of student answer paper by another staff member.<br>• Analysis the grades of students. |
| 3 Processes for Improvement of Teaching<br>• Preparing the course as PPT.<br>• Using scientific flash and movies.<br>• Coupling the theoretical part with laboratory part<br>• Periodical revision of course content. |
| 4. Processes for Verifying Standards of Student Achievement (e.g. check marking by an independent member teaching staff of a sample of student work, periodic exchange and remarking of tests or a sample of assignments with staff at another institution)<br>• The instructors of the course are checking together and put a unique process of evaluation.<br>• Check marking of a sample of papers by others in the department.<br>• Feedback evaluation of teaching from independent organization.<br>• Independent evaluation by another instructor that give the same course in another faculty.<br>• Evaluation by the accreditation committee in the university. |
| 5 Describe the planning arrangements for periodically reviewing course effectiveness and planning for improvement.<br>1- The following points may help to get the course effectiveness<br>• Student evaluation<br>• Course report<br>• Program report<br>• Program Self study<br>2- According to point 1 the plan of improvement should be given. |