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**Department of Physics**

**College of Science**

**University of Salahaddin**

**Subject: Mathematical physics**

**Course Book – (Year 3 – Medical physics)**

**Lecturer's name: *Dr. Salar Ali Mawlood***

**Academic Year: 2023/2024**

**Course Book**

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| **1. Course name** | **Mathematical and Computational physics** |
| **2. Lecturer in charge** | **Dr. Salar Ali Mawlood** |
| **3. Department/ College** | **Physics/Science** |
| **4. Contact** | **e-mail:** **salar.mawlood@su.edu.krd****Tel: 07504650846** |
| **5. Time (in hours) per week**  | **Theory: 3****Practical: 2**  |
| **6. Office hours** | **4** |
| **7. Course code** |  |
| **8. Teacher's academic profile**  | **I have more than 28 year experience teaching of different subjects such as: Properties of Matter, General Physics, Electricity and Magnetism, statistical mechanics, superconductivity ,also I have four (4) papers are published in different foreign journals.****B.Sc. of Physics from 1992****M.Sc. of Solid State Physics from 2003****Ph. D of solid state physics from 2015****Assist Lecturer** April 2003 – July 2015**Instructor** July 2015 – up to date**Assist Prof.** …………. |
| **9. Keywords** | **Mathematical physics, Matlab program , Gradient, Divergence, Curl, and Laplacian of scalar and/or vector fields ,special functions, Differential equations**  |
| **10. Course overview:**  At the beginning we are learn the principles of the main programming language which is Matlab program. The introduction of how to use this power computing system for handling the calculations in physics problems. This course is going to cover to some good extent all mathematical techniques that a student need to comprehend and pass all physics courses. As everybody knows that mathematics is the language of physical science and a powerful tool to express realities hidden in physical systems. The topics that one or two semesters of mathematical physics must cover are parts of a wide spectrum starting from calculus, linear algebra, differential equations, to complex numbers and complex analysis. Fortunately most of the mentioned topics are covered within separate courses in the same department. My major role then is to cover topics that are not taught in the other similar courses and place them in the mathematical physics course. The chosen topics are Vector analysis, the physical significance of partial derivative operators (Gradient, Divergence, Curl, and Laplacian), Double and Triple integrals in the three different coordinate systems, Special functions (Factorial, Gamma, Beta, The error function, and stirling’s formula), and finally the Sequence and Series as well as Fourier Series and Analysis.The basic computational physics which is the study and implementation of numerical algorithms in order to solve problems in physics for which a quantitative theory already exists. The computational method is widely used in solid state physics, fluid mechanics, band structure and magnetic properties of solid.  Different people learn in different ways. Therefore this course offers a learning environment with a diversified set of options that you can tailor to your individual learning style. There are class meetings, homework assignments, computational projects, and practice. There are many ways to get assistance with the material in this course: the office hours, appointments, e-mail, phone |
| **11. Course objective:** This course provides an introduction for undergraduate physics students to Mathematical physics. We will learn various techniques for solving physics problems numerically, using traditional programming, with the Matlab language.  The ultimate goal of this course is to force students improve their mathematical skills and to find the ability of understanding physical phenomena through rigorous mathematical formulae. The course will start with a brief description of Mathematical and computational physic: describing the first the language to computation problems . The language used to there is Matlab language, so the course begin with learning Matlab program which is the effective way to solving problem in physics because the simple of codes in Matlab as well as its widens of its applications. Further, the goal of this are:\_ To learn methods of solving physics problems numerically\_ To understand the advantages and limitations of common numerical techniques\_ Practice writing flexible, efficient, and practical code\_ Get acquainted with software development tools and systemsThis course is intended to give an introduction to main computational tools, techniques and methods used in contemporary physics. Student will practice writing, compiling, and running computer programs, together with analysis of results, and presentation of their results as scientific reports.This is not a course in computing science, or in programming. It focuses specifically on practical methods for solving physics problems. The course is therefore designed such that a significant fraction of the students’ time is spent actually programming specific physical problems. In this course the students should learn by doing.Thus, although we shall not need any truly complicated math, working knowledge of calculus, basic differential equations, and elements of linear algebra will be expected.**Computer Lab:** Physics Computer Lab weekly taken 2 hours for student to apply the program in Matlb language to solving problem practically |
| **12. Student's obligation**A list of additional useful problems will be given to help the student further sharpen your understanding of the subject and your problem solving skills. The students are required to do these problems, although you may find it useful to do so. Because this subject are two courses, so that the students are required to do at least two closed exam during this semester besides other assignments and each student must prepare full report at the end of the year. All exams have marks, full report also has marks, the classroom activities count marks and mark for attendance too. لێره‌ مامۆستا به‌رپرسیارێتی قوتابی خوێندکار ڕوونده‌کاته‌وه‌ سه‌باره‌ت به‌ کۆرسه‌که‌ بۆ نموونه‌ ئاماده‌بوونی قوتابیان له‌ وانه‌کاندا، له‌ تاقیکردنه‌وه‌کاندا، راپۆرت و ووتار نووسین... هتد.  |
| **13. Forms of teaching**Our lecture is depend directly on showing the strong point in the lecture via data show depending on the power point program… and solve problem on the white board with the students. And using Computers in Laboratory. لێره‌ مامۆستا ڕێگه‌ی وانه‌‌ ووتنه‌وه‌ ده‌نووسێت، بۆ نموونه‌:‌ داتاشۆ و پاوه‌رپۆینت، ‌سه‌ر ته‌خته‌ڕه‌ش، ته‌خته‌ی سپی، سمارتبۆرد یان‌ مه‌لزه‌مه‌... هتد |
| **14. Assessment scheme**All exams have 40 marks, full report has 5 marks, the classroom activities count and for attendance 5 Marks. So that the final grade will be based upon the following criteria:Mid- semester exam: 40%Classroom participation and assignments: 5%Report: 5%Final Exam: 50% .Breakdown of overall assessment and examinationلێره‌ مامۆستا جۆری هه‌ڵسه‌نگاندن (تاقیکردنه‌وه‌کان یان ئه‌زموونه‌کان) ده‌نووسێت بۆ نموونه‌ تاقیکردنه‌وه‌ی مانگانه‌، کویزه‌کان، بیرکردنه‌وه‌ی ڕه‌خنه‌گرانه (پریزه‌نته‌یشن)، ڕاپۆرت نووسین، ووتار نووسین‌ یان ئاماده‌نه‌بوونی خوێندکار له‌ پۆلدا...هتد. ئامانه‌ چه‌ند نمره‌ی له‌سه‌رده‌بێت و مامۆستا چۆن نمره‌کان دابه‌شده‌کات؟‌ |
| **15. Student learning outcome:** The ultimate goal of this course is to force students improve their mathematical skills and to find the ability of understanding physical phenomena through rigorous mathematical formulae.  Computational physics is now widely accepted as a third, equally valid complement to the traditional experimental and theoretical approaches to physics, its clearly relies upon areas that lie some distance from traditional physics curriculum. Computational physics provides a means to solve complex numerical problems. In itself it will not give any insight into a problem (after all, a computer is only as intelligent as its user), but it will enable you to attack problems which otherwise might not be solvable. Physics is a corner-stone of every technological fields. When you have a solid understanding of physics, and the computational know how to calculate solutions to complex problems. The Matlab language is used throughout this course. It is widely available, continually updated, and remains most commonly used programming language in science.پڕکردنه‌وه‌ی ئه‌م خانه‌یه‌ زۆر گرنگه‌، مامۆستا ده‌رئه‌نجامه‌کانی فێربوون ده‌نووسێت. بۆ نموونه‌: ڕوونی ئامانجه‌ سه‌ره‌کیه‌کانی کۆرسه‌که‌ (بابه‌ته‌که‌) بۆ خوێندکار‌گونجاندنی ناوه‌ڕۆکی کۆرسه‌که‌ به‌ پێویستی ده‌ره‌وه‌ و بازاڕی کارقوتابی چی نوێ فێرده‌بێت له‌ ڕێگه‌ی پێدانی ئه‌م کۆرسه‌وه‌؟This should not be less than 100 words  |
| **16. Course Reading List and References‌:****Books**: *There are many good introductory texts on Computational physics, for example:* * **Mary L. Boas: Mathematical Methods in the Physical Sciences. John Wiley $ Sons.**
* **S.L. Kakani and C. Hemrajani :** Mathematical Physics,
* **B. D. Gupta :** Mathematical Physics,
* **Chun Wa Wong:** Introduction to mathematical Physics, Methods and concepts**,**

**A. Gilat**: Matlab an introduction with applications, 4th Ed. John Wiley & Sons. Inc.▪ Key references:▪ Useful references:▪ Magazines and review (internet): |
| **17. The Topics:** | **Lecturer's name** |
| 1. An Introduction to Programming in Matlab
 | Dr.Salar Ali Mawloodex: (3 hrs)ex: 5/9/2022 |
| 1. Vectors and matrices
 | Dr.Salar Ali Mawloodex: (3 hrs)ex: 12/9/2022 |
| 1. Graphic using Matlab
 | Dr.Salar Ali Mawloodex: (3 hrs)ex: 19/9/2022 |
| 1. Plots with special graphics
 | Dr. Salar Ali Mawloodex: (3 hrs)ex: week Four |
| 1. Programming with matlab
 | Dr. Salar Ali Mawloodex: (3 hrs)ex: week five |
| 1. Looping and decision
 | Dr. Salar Ali Mawloodex: (3 hrs)ex: week Six |
| 1. The Mathematical form and the Physical significance of the gradient of a Scalar Field.
 | Dr. Salar Ali Mawloodex: (3 hrs) |
| 1. The mathematical formula and the physical significance of the divergence operator.
 | Dr. Salar Ali Mawloodex: (3 hrs) |
| 1. The physical significance of the Curl of a vector field
 | Dr. Salar Ali Mawloodex: (3 hrs) |
| 1. The Physical significance of the Laplacian operator
 | Dr. Salar Ali Mawloodex: (3 hrs) |
| 1. Double Integrals over rectangular regions.
 | Dr. Salar Ali Mawloodex: (3 hrs) |
| 1. Double Integrals over general regions
 | Dr. Salar Ali Mawloodex: (3 hrs) |
| 1. Coordinate systems

:Special Functions I: Factorial Function, Gamma Function (Recursion Relation), and The Gamma function of negative numbers | Dr. Salar Ali Mawloodex: (3 hrs) |
| 1. Special Function II: Beta Function, the relation between Beta and Gamma function.
 | Dr. Salar Ali Mawloodex: (3 hrs) |
| **19. Examinations:****Q1:** Find a symbolic solution for the area $A$ of the shaded region shown in figure below, where the curve is specified in polar coordinates and $B$ is a given positive constant. Check your solution for $B=2$ m.

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**Q2:** Verify that the volume element, $=ρ^{2}\sin(φ dρ dθ dφ)$ , when using spherical coordinates. **Q3: (a)** write a program to plotting a graph in polar coordinate for the function ( cos 3x), if 0 ≤ x ≤ π (b) write the flow chart of ( if….. elseif…..end) structure |
| **20. Extra notes:**Here the lecturer shall write any note or comment that is not covered in this template and he/she wishes to enrich the course book with his/her valuable remarks. |
| **21. Peer review پێداچوونه‌وه‌ی هاوه‌ڵ** This course book has to be reviewed and signed by a peer. The peer approves the contents of your course book by writing few sentences in this section.*(A peer is person who has enough knowledge about the subject you are teaching, he/she has to be a professor, assistant professor, a lecturer or an expert in the field of your subject).*ئه‌م کۆرسبووکه‌ ده‌بێت له‌لایه‌ن هاوه‌ڵێکی ئه‌کادیمیه‌وه‌ سه‌یر بکرێت و ناوه‌ڕۆکی بابه‌ته‌کانی کۆرسه‌که‌ په‌سه‌ند بکات و جه‌ند ووشه‌یه‌ک بنووسێت له‌سه‌ر شیاوی ناوه‌ڕۆکی کۆرسه‌که و واژووی له‌سه‌ر بکات.هاوه‌ڵ ئه‌و که‌سه‌یه‌ که‌ زانیاری هه‌بێت له‌سه‌ر کۆرسه‌که‌ و ده‌بیت پله‌ی زانستی له‌ مامۆستا که‌متر نه‌بێت.‌‌  |