Nuclear Track:

Master of Physics by Research Project

Table of Contents

Common courses

Course Title: **Mathematical Physics**

Course Code: **403600-3**

(C-1)

1. Topics to be Covered		
List of Topics	**No. of Weeks**	**Contact hours**
1-Suffix notation -Introduction to suffix notation -The Kronecker delta -The alternating tensor -The relation between Levi Civita and Kronecker delta, -Grad, div and curl in suffix notation	1	3
2-Cartesian tensors -Orthogonal transformations -Symmetry transformations -Vectors and scalar -Examples.	2	6
3- Curvilinear coordinates -Scale factor and basis vectors -General curvilinear coordinates -Vector operators in orthogonal curvilinear coordinates.	2	6
4-Tensors in Curvilinear coordinates -A covariant and contravariant vectors, -Mixed tensors -Properties of tensors -Metric tensor -Construction of higher order tensors	2	6
5-Differential equations of the special functions -Lagendre functions -Bessel functions - Hermite functions -Laguerre functions.	2	6

6-Functions of a complex variable -Analytic functions -Cauchy-Riemann -Contour integrals - The residue theorem	2	6
7-Integral Transform -The Fourier transform -Application of Fourier transform to differential equations -Laplacian Transform -Laplace transform and differential equations	2	6
8-Integral Equation -Transformation of a differential equation into an integral equation -Integral Equations with Generating functions -Separable Kernels	2	6
Total	15	45

5. Assessment Task Schedule for Students During the Semester

	Assessment task (i.e., essay, test, quizzes, group project, examination, speech, oral presentation, etc.)	**Week Due**	**Proportion of Total Assessment**
1	Online quizzes	All weeks	20%
2	Mid Term (1)	6th week	15%
3	Mid Term (2)	13th week	15%
4	Scientific project	14th Week	10%
5	Final Exam	16th week	50%

E Learning Resources

1. List Required Textbooks

1- George Arfken, Mathematical Methods for physicists, seventh edition, Academic press (2014) ISBN: 0-12-059876-0

2- Mary L. Boas, Mathematical methods in the Physical sciences, third edition, John Wiley and Sons (2006) ISBN 0-471-19826-9

3- G. Dennis Zill, R. Michael Cullen, Advanced engineering mathematics, Jones and Bartlett Publisher (2006), ISBN 9780763745912.

4- Sadri Hassani, Mathematical methods for students of physics and related fields; Springer Science+Buisness Media LLC (2009): ISBN: 978-0-387-09503-5.

5- Applications of tensor analysis, Dover applications, Inc., New York (2011), eISBN-13: 978-0-486-14502-0.

6- Tensors and Manifolds: with applications to physics, Robert H. Wasserman, Library of congress (2009), ISBN 978-0-19-851059-8.

2. List Essential References Materials (Journals, Reports, etc.)

Journalcra.com/article/applications-tensor-various-scientific-and-mathematics…

3. List Electronic Materials, Web Sites, Facebook, Twitter, etc.

(eg. www.youtube.com.)

4. Other learning material such as computer-based programs/CD, professional standards or regulations and software.

Course Title: **Statistical Physics**

Course Code: **403602-3**

(C-2)

1. Topics to be Covered		
List of Topics	**No. of Weeks**	**Contact hours**
The Canonical Ensemble: Method of the most probable distribution; The evaluation of the undetermined multipliers; Thermodynamic connections; Grand canonical ensemble.	2	4
Boltzmann, Fermi-Dirac and Bose-Einstein Statistics. The Maxwell-Boltzmann distribution function, the Bose-Einstein distribution function, the Fermi-Dirac distribution functions.	2	4
Ideal Monoatomic gas; The translational partition function; The electronic and Nuclear partition functions; Thermodynamic functions	2	4
Ideal Diatomic gas: The vibrational partition function; The rotational partition function of a heteronuclear diatomic molecule; The Symmetry requirement of the total wavefunction of a homonuclear diatomic molecule; The rotational partion function of a homonuclear diatomic molecule.	2	4
The Classical partition function: Phase-space and the Liouville equation; Equi-partition of energy.	2	4
Chemical Equilibrium: The Equilibrium constant in terms of partition functions; A weakly degenerate ideal Fermi-Dirac gas; A strongly degenerate ideal Fermi gas; A weaky degenerate ideal Bose -Einstein gas; A strongly degenerate ideal Bose - Einstein gas; An ideal gas of photons.	2	4
Quantum Statistical mechanics: Micro-canonical ensemble, Quantization of phase-space, Symmetry of wave functions, Effect of Symmetry on counting, Various distributions using micro-canonical ensemble.	3	4
	15 weeks	28 h.

E Learning Resources

1. List Required Textbooks

- -Thermodynamics, Kinetic theory, and statistical thermodynamics, 3rd edition, Francis W. Sears and Gerhard L. Salinger. ISBN-13: 978-0201068948 (1975).
- -Statistical thermodynamics revised printing, by Chang L. Tien and John H. Lienhard, ISBN-13: 978-0891168287 (1979).

- -M.D. Sturge, Statistical and Thermal Physics, Fundamentals and Applications (A.K. Peters, Natick, Massachusetts) ISBN 1-56881-196-9 (2003).
- -John Dirk Walecka , Introduction to Statistical Mechanics: First Edition, ISBN-13: 978-9814366212 (2011).
- John Dirk Walecka, INTRODUCTION TO STATISTICAL MECHANICS: SOLUTIONS TO PROBLEMS Paperback , ISBN-13: 978-9814366205 (2016).
- Werner Krauth, Statistical Mechanics: Algorithms and Computations (Oxford Master Series in Physics) PAP/CDR Edition, ISBN-13: 978-0198515364 (2006).

2. List Essential References Materials (Journals, Reports, etc.)

3. List Electronic Materials, Web Sites, Facebook, Twitter, etc.

.Electronic Materials, Web Sites etc.

4. Other learning material such as computer-based programs/CD, professional standards or regulations and software.

There are so many computer programs that can be used Mathematical program, Maple, Matlab, etc

Course Title: **Electrodynamics**

Course Code: **403604-3**

(C-3)

C. Course Description (Note: General description in the form used in the program's bulletin or handbook)

1. Topics to be Covered		
List of Topics	**No. of Weeks**	**Contact hours**
❖ **Boundary Value Problems:** Review of vector analysis, Reviw of the electrostatic and magnetostatic fields, including the polarisation field in dielectrics and the magnetisation field in magnetisable media; Potential theory (boundary value problems, uniqueness theorem, method of images, separation of variables) with applications in electrostatics, magnetostatics and stationary current distributions.	**4**	**12**
❖ **Maxwell's Equations and Conservation Laws:** Induction law and displacement current, Maxwell Equations, Vector and Scalar Potentials, Gauge Transformation, Lorantz Gauge, Coulombs Gauge, Green Functions for The Wave Equation, Poynting's Theorem and Conservation of Energy and Momentum for a system of Charged Particles and Electromagnetic Fields, Poynting's Theorem for Harmonic Fields, Fields Definition of Impedance and Admittance, Transformation Properties of Electromagnetic, Fields and Sources under Rotations, Spatial Reflections, and Time Reversal.	**4**	**12**
❖ **Electromagnetic Waves:** Plane Waves in a Nonconducting Isotropic Media, Polarization; Stokes Parameters; Reflection and Transmission, Total Internal Reflection; Goos–Hänchen Effect; Dispersive materials, phase/group velocities, Propagation in plasmas, conductors, dielectrics; Waves at media interfaces, Fresnel equations.	**4**	**12**
❖ **Radiating Systems:** Fields and Radiation of a Localized Oscillating Source; Electric Dipole Fields and Radiation; Magnetic Dipole and Electric Quadrupole Fields; Linear Antenna; Spherical Wave Solutions of the Scalar Wave Equation, Multipole Expansion of the Electromagnetic Fields; Properties of Multipole Fields, Energy and Angular Momentum of Multipole Radiation; Sources of Multipole Radiation; Multipole Moments.	**3**	**12**
	15 weeks	**45 hrs**

5. Assessment Task Schedule for Students During the Semester			
	Assessment task (i.e., essay, test, quizzes, group project, examination, speech, oral presentation, etc.)	**Week Due**	**Proportion of Total Assessment**
1	**Exercises & Home works**	**All weeks**	**10%**
2	**Participation in activities during lectures**	**All weeks**	**10%**
3	**1st Periodic Exam**	**8th week**	**15%**
4	**2nd Periodic Exam**	**11th week**	**15%**
5	**Final Exam**	**16th week**	**50%**

E Learning Resources

1. List Required Textbooks

1- Classical Electrodynamics Third Edition, by John David Jackson, Wiley 1998.

2- Introduction to Electrodynamics 4th Edition, by David J. Griffiths, Cambridge University Press 2017.

3- Classical Electromagnetic Radiation, Third Edition Third Edition, by Mark A. Heald and Jerry B. Marion, Courier Corporation 2012.

4- Classical Electricity and Magnetism: Second Edition, by Wolfgang K. H. Panofsky and Melba Phillips, addison Wesley 2005.

Course Title**: Computational Physics**

Course Cod**: 403606-3**

(C-4)

C. Course Description (Note: General description in the form used in the program's bulletin or handbook)

1. Topics to be Covered		
List of Topics	**No. of Weeks**	**Contact hours**
-Programming: Variables and arrays. Displaying output data, Data files, scalar and array operations, Built in functions. , the while Loop, the FOR Loop**.** Preserving data between calls to a function, subroutines.	2	6
-Linear Algebra: Solving a linear system, Gaussian elimination . Finding eigenvalues and eigenvectors, Matrix factorizations and examples.	1	3
-Curve fitting and interpolation: Polynomial fitting, Least square fitting, non-linear fits and examples, interpolation of data.	1	3
-Numerical integration and differentiations: Integration, differentiations, solving first order and second order Linear equation.	1	3
-Modelling: Harmonic motion example using a variety of numerical approaches.	2	3
-Modelling: The Solar system: Kepler's laws, planetary motion using different time steps, Orbits using different force laws. The three body problem and the effect of Jupiter on Earth.	1	**3**
Modelling: Potentials and Fields: Solution of Laplace's equation using the Jacobi relaxation method. Solutions of Laplace's Equation for a finite sized capacitor. Potentials and Fields near Electric Charges, Poisson Equation.	2	**3**
-Modelling: Waves: Waves on a string. Waves on a string with free ends. Frequency spectrum of waves on a string.	2	**3**
Modelling: Monte-Carlo. Random Walk simulation. Markov-Chain techniques for simulating the Ising spin model in statistical mechanics.	2	**3**
-Modelling: -Quantum Mechanics: Time independent Schrodinger Equation. Wave packet construction. Time dependent Schrodinger Equation.	1	**3**
	15 weeks	**45 hrs.**

5. Assessment Task Schedule for Students During the Semester

	Assessment task (i.e., essay, test, quizzes, group project, examination, speech, oral presentation, etc.)	Week Due	Proportion of Total Assessment
1	Exercises & Home works	All weeks	5%
2	Online quizzes	All weeks	5%
3	Oral exam	5th Week	5%
4	Participation in activities lectures and labs	All weeks	5%
5	Test (1)	6th week	10%
6	Test (2)	13th week	10%
7	Scientific project	14th Week	10 %
8	Final Exam	16th week	50%

E Learning Resources

1. List Required Textbooks

-"Mastering Matlab 7" by Duane C. Hanselman and Bruce L. Littlefield, Prentice Hall, ISBN-13: 978-0136013303 (2011).
-"Computational Physics using Matlab" Second Edition, by Nick Giordano and Hisao Nakanishi, ISBN: 0-13-146990-8 (2005).

-"Introduction To Computational Physics Using Matlab", Khusniddin K. Olimov, Erkin Kh. Bozorov , (2017).

-"Computational Physics (2nd Edition)" Nicholas J. Giordano, Hisao Nakanishi, ISBN-13: 978-0131469907 (2005).

2. List Essential References Materials (Journals, Reports, etc.)

-"Mathematics for Physics: An Illustrated Handbook (Computational Mathematical and) 1st Edition, Kindle Edition" ISBN-13: 978-9813233911 (2017).

-"Computational Physics 2nd Edition", Jos Thijssen, ISBN-13: 978-1107677135 (2013)

Course Title: **Research methodology**

Course Code: **403643-3**

(C-0)

1. Topics to be Covered		
List of Topics	**No. of Weeks**	**Contact hours**
Course overview and introduction to the Study: Introduction (why the study was selected, background and setting), Statement of Problem, Purpose of the Study, Importance of the Study, Definition of Terms (if needed)	1	3
Review of Related Literature: This chapter should contain a concise presentation of literature and research (periodicals, dissertation abstracts, books, etc.) relevant to the problem.	2	6
Developing a bibliography and properly citing sources within text Online Reading: Citing Sources	2	6
SCIENCE GRAPHICS: Discussion and illustration of the importance of clear graphical presentation of data. Review basic guidelines and critically examine good and bad examples from the literature. Producing effective and publishable figures using a suitable software	2	6
WRITING AN IMRaD MANUSCRIPT: INTRODUCTION & METHODS. Review the functions, writing style, and content of Introduction and Methods sections.	2	6
Research Presentations: - Making scientific posters; Detailed instructions will be given on the design and development of a poster in class. - Making scientific papers; Detailed instructions will be given on the design and development of a paper in class. - students will present material to the class.	2	6
Library Research & Resources Practice (class in the library): Organization of Knowledge: Metadata and searching for information Online Reading: Library Catalog, Keyword Searching, and Subject Searching.	2	6
Evaluating Web Sites Online Reading: Evaluate Web Sites (reliable website with information related to your research topic.). Information ethics: Copyright, plagiarism Online Reading: Plagiarism	2	6
Total number	15 hrs	45 hrs

	Assessment task (i.e., essay, test, quizzes, group project, examination, speech, oral presentation, etc.)	Week Due	Proportion of Total Assessment
1	Oral presentation (1)	6th week	10%
2	First Report (1)	6th week	15%
3	Oral presentation (2)	10th week	10%
4	Second Report (2)	10th week	15%
5	Scientific project report related to thesis	14th Week	50 %
	Total		100%

E Learning Resources

1. List Required Textbooks

1- John W. Creswell , J. David Creswell, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE Publications, Inc; Fifth Edition (2018) ISBN-13: 978-1506386706
2- Ron Iphofen, Martin Tolich Handbook of Qualitative Research. Sage, (2018) ISBN-13: 978-1473970977
3- Contemporary Field Research: Perspectives and Formulations. Prospect Heights, IL: Waveland Press (2001) ISBN-13: 978-1577661856
4- William Strunk Jr., Virginia Campbell , "The Elements of Style: Simplified and Illustrated for Busy People" (2018) ISBN-13: 978-1980205197.
5- William Badke, Research Strategies:6th edition (2018) ISBN-13: 978-1532018039

Elective Courses

Course Title: **Advanced programming**

Course Code: **403647-3**

(E-1)

1. Topics to be Covered		
List of Topics	**No. of Weeks**	**Contact hours**
Basics- Program construction, Output using "cout", Header files, when to use comments, Integer variables, variable names, integer constants the "endl" manipulator, exercises.	1	3
Basics- Character variables, character constants, escape sequence, input with "cin", floating point type, type bool, "setw" manipulator, the "iomanip" header file, arithmetic operation, library functions, exercises.	1	3
Loops and decisions – Relational operators, Loops, the "for" loop, the "while" loop, the "do" loop, Decisions, the "if" statement, the "if else" statement, the "switch" statement, the conditional operator	1	3
Loops and decisions- Logical operators, logical "AND" operator, logical "OR" operator, logical "Not" operator, the "break" statement, the "continue" statement, exercises	1	3
Structures- A simple structure, Defining the structure, accessing structure members, Structure within Structures, Structures and Classes, Enumeration, examples, exercises	1	3
Functions- Simple functions, the function declaration, calling the function, the function definition, passing arguments to functions, passing constants, passing variables, passing by value, Returning values from functions, the return statement, Returning structure variables	1	3
Functions- Reference arguments, Passing Data types by reference, Passing more complex pass by Reference, Passing Structures by Reference, Overloaded functions, inline functions, Returning by References.	1	3
Objects and Classes- A simple class, classes and objects, defining the class, using the class, calling member functions	1	3
Objects and Classes- Constructors, Destructors, objects as function arguments, overloaded constructors, Member functions defined outside the class, Static class data, const and classes.	1	3
Arrays- Array fundamentals, arrays as class member data, arrays of objects and exercises	1	3
Pointers– Addresses and pointers, Pointers and arrays, examples	1	3

Pointers- Pointers and functions, the "new" and "delete" operators examples.	1	3
Inheritance- Derived class and base class, Derived class constructors, class inheritance, Public and private inheritance.	1	3
Virtual functions- Normal member functions accessed with pointers, virtual member functions accesses with pointers, friend functions, static functions, examples	2	6
Total number	15	45

5. Assessment Task Schedule for Students During the Semester

	Assessment task (i.e., essay, test, quizzes, group project, examination, speech, oral presentation, etc.)	Week Due	Proportion of Total Assessment
1	Exercises & Home works	All weeks	5%
2	Online quizzes	All weeks	5%
3	Oral exam	5th Week	5%
4	Participation in activities lectures and labs	All weeks	5%
5	Test (1)	6th week	10%
6	Test (2)	13th week	10%
7	Scientific project	14th Week	10 %
8	Final Exam	15th week	50%
	Total		100%

E Learning Resources

1. List Required Textbooks

1- Object oriented programming in C++, Robert Lafore, fourth edition, Pearson and Sam Publishing (2002), ISBN 0-672-32308-7.
2- Object oriented programming using C++, Joyce Farrel, fourth edition, 2009, ISBN-13: 978-1-4239-0257-7.
3- Bjarne Stroustrup, The C++ Programming Language, 4th Edition (2013), ISBN-13: 978-0321563842.
4- -"Applied Computational Physics 1st Edition" Joseph F. Boudreau, Eric S. Swanson ISBN-13: 978-0198708643 (2018).

2. List Essential References Materials (Journals, Reports, etc.)

-Siddhartha Rao, "C++ in One Hour a Day, Sams Teach Yourself (8th Edition)", (2016) ISBN-13: 978-0789757746.

-Bjarne Stroustrup, "A Tour of C++ (C++ In-Depth Series)" , (2018), ISBN-13: 978-0134997834.

Course Title: **Advanced Research lab.**

Course Code: **403651-3.**

(E-2)

1. Topics to be Covered		
List of Topics	**No. of Weeks**	**Contact hours**
Introduction of material science laboratory.	1	3
Preparation of nanomaterial by chemical method and Preparation of nanomaterial by ball milling method and measurement it by UV-visible spectroscopy.	3	9
Preparation of thin films by spin coating and study their electrical conductivity by temperature-four probe method	2	6
Preparation of biopolymer material and study the morphology and crystal growth rate by polarized optical microscopy (POM).	2	6
Determination of the elongation at break and Young's modulus of polymer film by Tensile test.	1	3
Determination of dielectric constant, dielectric loss and Electrical conductivity of some material by impedance analyzers.	2	6
Preparation of thin film by vacuum thermal evaporation of and study the morphology by SEM.	1	3
Study of crystal size by using XRD and the cell Scherrer formula for some crystalline material.	1	3
Study the Surface morphology for some material by atomic force microscopy (AFM).	1	3
Study the I-V characteristics for solar cell temperature-two probe method	1	3
	15 weeks	**45 hrs.**

5. Assessment Task Schedule for Students During the Semester			
	Assessment task (i.e., essay, test, quizzes, group project, examination, speech, oral presentation, etc.)	**Week Due**	**Proportion of Total Assessment**
1	During the examination period following the module, an oral exam (duration: 30 min.) on "certain experimental" is held.	14th week	20 %
2	Experimental reports	Each week	40 %
3	Final exam	15th week	40%

E Learning Resources

1. List Required Textbooks
During the lab course, a set of references is given for each experiment. Manuals are available for all experiments; they contain individual literature references for all experiments.

Course Title: **Semiconductor device modeling**

Course Code: **403649**-3

(E-3)

1. Topics to be Covered		
List of Topics	**No. of Weeks**	**Contact hours**
❖ **Semiconductor Carrier Transport Equations:** Semiconductor bandstructure, Simplified bandstructure models, Carrier dynamics, Semiconductor effective mass, Semiclassical transport theory, Boltzmann transport equation, Maxwell's equations, Drift-Diffusion Transport Model, equations, Boundary conditions, Generation-recombination, Scattering processes, Relaxation time approximation, Thermal Conductivity and Heat flow.	**3**	**9**
❖ **Analytical modeling and analysis of semiconductor Devices:** Techniques for solving Semiconductor equations, closed – form analysis, Mobility modeling, Analysis of pn Junction Diode, Analysis of Field Effect Transistor operation, , Analysis of MOSFET operation, limitation of the closed – form analysis.	**2**	**6**
❖ **Numerical solution of the Semiconductor equations:** Finite-Difference Schemes: Discretization of Semiconductor equations, methods for solving finite difference equations, Boundary Conditions, Simulation examples. Finite Element Method: Galerkin Method, Derivation of the Finite Element equations, Simulation examples. Modeling Heterojunction Devices: Semiconductor equations for Heterojunction, High Electron Mobility Transistors, Analytical solutions, Numerical Models, Heterojunction Bipolar Transistors, and Monte Carlo Simulations.	**4**	**12**
❖ **Monte Carlo Method:** Modeling carrier transport in Semiconductors, Equations of motion, Energy band structure, Application Monte Carlo Method for transport Characteristics and device modeling.	**2**	**6**
❖ **Introduction to Quantum transport theory:** Quantum theoretical foundations, state vectors, Schroedinger and Heisenberg picture, Band structure, Bloch theorem, one dimensional periodic potential, density of states, Pseudopotential theory, crystal symmetries, reciprocal lattice, Brillouin zone, Semiclassical transport theory, Quantum Transport Theory, limits of semiclassical transport theory, quantum mechanical derivation Boltzmann transport equation, Markov-Limes.	**4**	**12**
	15 weeks	**45 hrs**

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

		Lecture	Tutorial	Laboratory/ Studio	Practical	Other	Total
Contact Hours	Planned	30	15	0	0	0	45
	Actual	30	15	0	0	0	45
Credit	Planned	2	1	0	0	0	3
	Actual	2	1	0	0	0	3

3. Individual study/learning hours expected for students per week.	6

E Learning Resources

1. List Required Textbooks

- D. Vasileska, S. M. Goodnick, G. Klimeck, “Computational Electronics: Semiclassical and Quantum Device Modeling and Simulation 1st Edition”, CRC Press, 2010.
- C. Snowden, “Introduction to Semiconductor Device Modeling”, World Scientific, 1998.
- Fundamentals of Carrier Transport 2nd Edition, Cambridge University Press (2000).
- Carlo Jacoboni and Paolo Lugli, "The Monte Carlo Method for Semiconductor Device Simulation", Springer, 2002.

Nuclear Track

Course Title:

Introduction to Nuclear and High Energy Physics

Course Code: **403638-3**

(N-1)

Course Description:		
1. Topics to be Covered		
List of Topics	**No. of Weeks**	**Contact hours**
1- Properties of Nuclei	2	6
1- Masses, Sizes		
2- Nuclear Spins		
3- dipole moments.		
4- Stability and instability.		
5- Nuclear Force		
2- Nuclear Models	3	9
1- Liquid Drop Model		
2- Shell Model		
3- Collective model		
3- Strong, Weak and Electromagnetic interactions at work	4	12
1- Alpha Decay		
2- Beta Decay		
3- Gamma Decay		
4-Intoduction to Elementary Particles	3	9
1- Historical introduction to elementary particles		
2- How do we produce elementary particles		
3- How do we detect elementary particles		
4- The eight fold way		
5- The Quark model		
6- The Standard model		
5- Elementary Particle Dynamics	3	9
1- The four forces		
2- Quantum Electrodynamics		
3- Decays and conservation laws		
4- Unification schemes		

2. Course components (total contact and credit hours per semester):							
		Lecture	**Tutorial**	**Laboratory/ Studio**	**Practical**	**Other**	**Total**
Contact Hours	Planned	45 hrs	45 hrs				90 hrs
	Actual	45 hrs	45 hrs				90 hrs
Credit	Planned	45 hrs	45 hrs				90 hrs
	Actual	45 hrs	45 hrs				90 hrs

5. Assessment Task Schedule for Students During the Semester			
	Assessment task (i.e., essay, test, quizzes, group project, examination, speech, oral presentation, etc.)	**Week Due**	**Proportion of Total Assessment**
1	Midterm 1	5th week	15 %
2	Midterm 2	10th week	15 %
3	Online quizzes	every week	10 %
4	Homework	Every week	5 %
5	Oral exam	Every week	5 %
6	Final exam	End of semester	50 %

E Learning Resources

1. List Required Textbooks

1) A. Das and T. Ferbel, Introduction to nuclear and particle physics (second edition) World Scientific (2003) ISBN 981-238-744-7.
2) R.C. Verma & S.C. Gupta, V.K. Mittal, Introduction to nuclear and particle physics 4th Edition, Kindle Edition (2018) ISBN-13: 978-9387472617
3) Books Wagon, Basic Ideas And Concepts In Nuclear Physics: An Introductory Approach 3Rd Edition (Series In Fundamental And Applied Nuclear Physics) (2017). ISBN 0 7503-0534 7 hbk, 07503 0535 pbk.
4) Burcham, Nuclear and Particle Physics: An Introduction 2nd Edition (2009) ISBN-13: 978-0470742754.
5) Kenneth S. Krane , Introductory nuclear Physics, first edition, Jone Wily & Sons Inc. (2008) ISBN 0 - 471-80553-X .
6) Saverio D'Auria, Introduction to Nuclear and Particle Physics, Springer; 1st ed (2018) **ISBN-13:** 978-3319938547.

7) Alessandro De Angelis, Mário Pimenta, Introduction to Particle and Astroparticle Physics: Multimessenger Astronomy and its Particle Physics Foundations (2018) ISBN-13: 978-3319781808.

8) Irving Kaplan, Nuclear Physics, Narosa Publishing House (2002). **ISBN-13:** 978-8185015897

9) K. Langanke, J. A. Maruhn, Steven E. Koonin, Computational Nuclear Physics 1: Nuclear Structure (1991) ISBN-13: 978-0387535715.

Course Title: **Nuclear Reactions**

Course Code: **403640-3**

(N-2)

1. Topics to be Covered

1- Chapters 11-14 of K. S. Krane, Introductory nuclear physics (see references below)

List of Topics	No. of Weeks	Contact hours
1. Kinematics in Nuclear Reactions: 1- Types of reactions and conservation laws 2- Energetics of nuclear reactions 3- Reaction cross sections 4- Coulomb scattering 5- Nuclear scattering 6- The Optical model 7- Direct and compound nuclear reactions **8-** Resonance and Heavy-ion reactions	**5**	**15**
2- Neutron Physics 1- Neutron sources 2- Absorption and moderation of neutrons 3- Neutron reactions and cross sections 4- Neutron capture 5- Interference and diffraction with neutrons	**4**	**12**
3-Nuclear fission 1- Characteristics of fission 2- Energy in fission 3- Fission and nuclear structure 4- Controlled Fission reactions **5-** Fission reactors	**3**	**9**
4-Nuclear fusion 1- Basic Fusion processes 2- Characteristics of fusion 3- Solar Fusion 4- Controlled Fusion reactors	**3**	**9**
Total	**15**	**45**

Lecture : 45 hrs	**Tutorial:**	**Lab:**	**Total:** 45 hrs

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

		Lecture	Tutorial	Laboratory/ Studio	Practical	Other	Total
Contact	Planned	**45 hrs**	**45 hrs**				**90 hrs**

Hours	Actual	**45 hrs**	**45 hrs**				**90 hrs**
Credit	Planned	**45 hrs**	**45 hrs**				**90 hrs**
	Actual	**45 hrs**	**45 hrs**				**90 hrs**

3. Individual study/learning hours expected for students per week.	**8**

5. Assessment Task Schedule for Students During the Semester

	Assessment task (i.e., essay, test, quizzes, group project, examination, speech, oral presentation, etc.)	**Week Due**	**Proportion of Total Assessment**
1	Exercises & Home works	All weeks	5 %
2	Participation	All weeks	5 %
3	In-Class Problem Solving	7th,13th week	10%
4	Midterm 1	6th week	15%
5	Midterm 2	10th week	15%
6	Final Exam	16th week	50%
	The Total		100%

E Learning Resources

1. List Required Textbooks

1. Kenneth S. Krane , Introductory nuclear Physics, first edition, Jone Wily & Sons Inc. (2008) ISBN 0 - 471-80553-X .
2. Hans Paetz gen. Schieck, "Nuclear Reactions: An Introduction (Lecture Notes in Physics) 2014th Edition" ISBN-13: 978-3642539855.
3. C.A. Bertulani , P. Danielewicz , "Introduction to Nuclear Reactions (Graduate Student Series in Physics) 1st Edition" (2004) ISBN-13: 978-0750309325.
4. Karlheinz Langanke, J.A. Maruhn , S.E. Koonin , "Computational Nuclear Physics 2: Nuclear Reactions " (1993) ISBN-13: 978-0387979540.

1. List Essential References Materials (Journals, Reports, etc.)

- Edmund Storms, The Explanation of Low Energy Nuclear Reaction: An Examination of the Relationship Between Observation and Explanation (2014) ISBN 978-1-892925-10-7 .
-Ian J. Thompson, Filomena M. Nunes , "Nuclear Reactions for Astrophysics: Principles, Calculation and Applications of Low-Energy Reactions", ISBN-13: 978-0849385483 (2009)

Course Title: **Quantum Field Theory**

Course Code: **403642-3**

(N-3)

1. Topics to be Covered		
List of Topics	**No. of Weeks**	**Contact hours**
1. Electromagnetic Field • Particles and fields • Electromagnetic field in the absence of charges • Electric dipole interaction • Electromagnetic field in the presence of charges	**1**	**3**
2. Lagrangian Field theory • Relativistic notation • Classical Lagrangian and Hamiltonian equations. • Quantized Lagrangian field theory • Symmetries and conservation laws	**2**	**6**
3. Spin-0 Fields: The Klein Gordon Equation • The neutral Klein Gordon Field • The Charged Klein Gordon Field • The invariant commutation relation	**2**	**6**
4. Spin-1/2 Fields: The Dirac Equation • The Dirac equation • Canonical quantization of the Dirac Field • The Fermion propagator	**3**	**9**
5. Photons: Covariant theory • The classical fields • Covariant quantization • The photon propagator	**2**	**6**
6. The S-matrix expansion • Natural dimensions and units • The S-matrix expansion • Wick's theorem	**2**	**6**
7. Feynman diagrams and rules in QED • Feynman Diagrams in configuration space • Feynman Diagrams in momentum space • Feynman rules for the S-Matrix • Feynman rules for QED	**3**	**9**

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

		Lecture	**Tutorial**	**Laboratory/ Studio**	**Practical**	**Other**	**Total**
Contact Hours	Planned	45 hrs	45 hrs				90 hrs
	Actual	45 hrs	45 hrs				90 hrs
Credit	Planned	45 hrs	45 hrs				90 hrs
	Actual	45 hrs	45 hrs				90 hrs

3. Individual study/learning hours expected for students per week.	8

5. Assessment Task Schedule for Students During the Semester

	Assessment task (i.e., essay, test, quizzes, group project, examination, speech, oral presentation, etc.)	**Week Due**	**Proportion of Total Assessment**
1	Exercises & Home works	All weeks	5 %
2	Participation	All weeks	5 %
3	In-Class Problem Solving	7th,13th week	10%
4	Midterm 1	6th week	15%
5	Midterm 2	10th week	15%
6	Final Exam	16th week	50%

E Learning Resources

1. List Required Textbooks
   - Graham Shaw and Franz Mandl, Quantum Field theory, John Wiley and Sons (2016), **ISBN-13:** 978-8126565061

2. List Essential References Materials (Journals, Reports, etc.)
   - Bipin R. Desai, Quantum Mechanics with basic field theory (2010) Cambridge university press, ISBN 978-0-521-87760-2
   - Andrei Smilga, Quantum Field Theory for the Gifted Amateur (2015) ISBN-13: 978-0199699339.
   - Andrei Smilga Digestible Quantum Field Theory 1st ed. (2017) Edition" ISBN-13: 978-3319599205.
   - Hagen Kleinert, "Particles and Quantum Fields ", (2016) ISBN-13: 978-9814740906 .
   - Eberhard Zeidler , Quantum Field Theory I: Basics in Mathematics and Physics: A Bridge between Mathematicians and Physicists 2nd printing 2009. ISBN-13: 978-3540347620.

Course Title: **High Energy Physics**

Course Code: **403639-3**

(N-4)

1. Topics to be Covered		
List of Topics	**No. of Weeks**	**Contact hours**
1. Relativistic Kinematics • Lorentz transformation • Four vectors • Energy and momentum • Collisions • Examples and applications	2	6
2. Symmetries and invariance principles • Conservation laws • Spin and angular momentum • Flavor symmetries • Parity • Charge conjugation, CP violation, TCP theorem.	4	12
3. Feynman calculus • Life times and cross sections • The Golden rule • Toy theory • Scattering • Higher order diagrams	4	12
4. Quantum Electrodynamics • Dirac Equation • Solutions to Dirac Equation • Bilinear Covariant • The Photon • Feynman rules for QED • Cross sections and lifetimes	5	15

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

		Lecture	**Tutorial**	**Laboratory/ Studio**	**Practical**	**Other**	**Total**
Contact Hours	Planned	45 hrs	45 hrs				90 hrs
	Actual	45 hrs	45 hrs				90 hrs
Credit	Planned	45 hrs	45 hrs				90 hrs
	Actual	45hrs	45hrs				90 hrs

3. Individual study/learning hours expected for students per week.	8

5. Assessment Task Schedule for Students During the Semester			
	Assessment task (i.e., essay, test, quizzes, group project, examination, speech, oral presentation, etc.)	**Week Due**	**Proportion of Total Assessment**
1	Online quizzes	every week	5 %
2	Homework	Every week	10 %
3	Midterm 1	7th week	15 %
4	Midterm 2	14th week	15 %
5	Interactive discussions	Every week	5 %
6	Final exam	End of semester	50 %

E Learning Resources

1. List Required Textbooks

1. David Griffiths, Introduction to elementary particles (2008) Wiley-VCH Verlag GmbH and Co. K GaA, Weinheim, ISBN-13: 978-3527406012.
2. Robert Purdy, "Particle Physics: An Introduction (Essentials of Physics Series)", (2018) ISBN-13: 978-1683921424.
3. Brian R. Martin and Graham Shaw, "Particle Physics (Manchester Physics Series) 4th Edition" (2017) ISBN-13: 978-1118912164.
4. Francis Halzen and Alan D. Martin, Quarks and Leptons: an introductory course in modern particle physics (2008) John Wiley and Sons, Inc. **ISBN-13:** 978-8126516568

Course Title: **Detector Physics**

Course Code: **403641-3**

(N-5)

2. Topics to be Covered		
List of Topics	**No. of Weeks**	**Contact hours**
1- Interactions of electrons and charged heavy particles in matter - Cross section, mean free path, surface density units. - Bohr's calculations - The Bethe-Bloch formulae - Energy dependence -Scaling law for dE/dx -Mass stopping power -Limitations on the Bethe-Bloch Formula and other effects. - Channeling -Range	**3**	**9**
2- Counting statistics and error prediction -Characterization of data -Statistical models -Applications of statistical models -Error propagation -Optimization of counting experiments -Limits of detectability -Distribution of time intervals	**3**	**9**
3- Radiation detectors -Simplified detector model -Modes of detector operation -Pulse Height spectra -Counting curves and plateaus -Energy resolution -Detection efficiency -Dead time	**2.5**	**7.5**
4- Ionization Detectors		

-Gaseous ionization detectors -Ionization and transport phenomena in Gases -Transport of electrons and ion in Gases -Proportional counter -Drift chamber -Liquid ionization detectors	**2.5**	**7.5**
5-Gamma ray detectors		
-The Photon-cathode -Photomultiplier tube characteristics -Scintillation pulse shape analysis - Germanium detector configurations	**2**	**6**
6-Neutron detection		
-Nuclear reactions of interest in neutron detection - Detectors based on boron reaction - counters based on neutron moderation - Detectors based on fast neutron induced reactions	**2**	**6**
Total	**15**	**45**

Lecture : 45 hrs	**Tutorial:**	**Lab:**	**Total: 45 hrs**

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

		Lecture	Tutorial	Laboratory/ Studio	Practical	Other	Total
Contact Hours	Planned	45 hrs	45 hrs				90 hrs
	Actual	45 hrs	45 hrs				90 hrs
Credit	Planned	45 hrs	45 hrs				90 hrs
	Actual	45 hrs	45 hrs				90 hrs

3. Individual study/learning hours expected for students per week.	**8**

5. Assessment Task Schedule for Students During the Semester			
	Assessment task (i.e., essay, test, quizzes, group project, examination, speech, oral presentation, etc.)	**Week Due**	**Proportion of Total Assessment**
1	Exercises & Home works+ quizzes	All weeks	5%
1	Assay	15th week	5%
3	Report	All weeks	20 %
4	Written Test (1)	6th week	10%
5	Written Test (1)	11th week	10%
6	Final examination	16th week	50%
	The Total		100%

E Learning Resources

1. List Required Textbooks

1. William R. Leo, Techniques for nuclear and particle physics, Springer Verlag (1987) ISBN 3-540-17386-2 Springer Verlag Berlin Heidelbergy New York
2. Glenn F. Knoll, Radiation Detection and Measurement, John Wiley & Sons, Inc. (1999) ISBN 0-471-07338-5.
3. Stefaan Tavernier, Experimental Techniques in Nuclear and Particle Physics 2010th Edition, ISBN-13: 978-3642008283.
4. Lucio Cerrito , Radiation and Detectors: Introduction to the Physics of Radiation and Detection Devices (Graduate Texts in Physics) 1st ed. (2017) Edition, ISBN-13: 978-3319531793.
5. Claus Grupen and Boris Shwartz , Particle Detectors (Cambridge Monographs on Particle Physics, Nuclear Physics and Cosmology) 2nd Edition (2011) ISBN-13: 978-0521187954.
6. Olaf Behnke , Kevin Kroninger, Gregory Schott, Thomas Schorner-Sadenius , Data Analysis in High Energy Physics: A Practical Guide to Statistical Methods (2013) ISBN-13: 978-3527410583.

2. List Essential References Materials (Journals, Reports, etc.)

1. Journal :Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment.
2. Geoffrey G Eichholz and John W.Poston, Principles of Nuclear Radiation Detection, Ann Arbor Science Publishers (April 1, 1980) ISBN-13: 978-0250402632