# Study Plan for the Bachelor's Degree in Physics

The Department of Physics at Yarmouk University offers a Bachelor's Degree on completion of the following requirements:

1. The fulfillment of the conditions stated in the regulations of awarding the Bachelor's degree at Yarmouk University No. (2) for the year 1991 and its amendments issued in accordance with the bylaws of awarding academic degrees and diplomas at Yarmouk University No. 76 for the year 1976.
2. University course requirements stated under the above regulations.
3. Faculty of Science course requirements stated earlier.
4. Department course requirements:

I. **Single Major** (86 Credit Hrs.):

(1) Obligatory courses (65) (Credit Hrs.):

Phys. 102, Phys. 103, Phys. 105, Phys. 106, Phys. 107, Phys. 201, Phys. 221A, Phys. 225, Phys. 227, Phys. 235, Phys. 251, Phys. 253, Phys. 261, Phys. 281B, Phys. 301, Phys. 311, Phys. 312, Phys. 322, Phys. 332, Phys. 333, Phys. 352, Phys. 353, Phys. 462, Phys. 481, Math. 102, Math. 201.

(2). Elective courses (21 Credit Hrs.):

a- (15 Credit Hrs.): chosen from the following courses offered by the department of Physics:

Phys. 282, Phys. 306, Phys. 341, Phys. 343A, Phys. 401, Phys. 424, Phys. 433, Phys. 441, Phys. 443, Phys. 444, Phys. 446, Phys. 451, Phys. 471, Phys. 482, Phys. 492, Phys. 499A, Phys. 499B, Phys. 499C.

b- (6 Credit Hrs.): chosen from the courses offered by the Departments of the Faculty of Sciences or the Departments of the Faculty of Information Technology and Computer Sciences

Math 203, Math 241, Stat 111, Stat 201, Chem.102, Chem.215, Chem.341, Bio 102, Bio 201, Bio 204, Geo 102, Env 101B, CIS 103, MIS 120, CS 130.

**Table (1)**
**Single Major Credit Hours**

| Requirements | Obligatory | Elective | Total |
|---|---|---|---|
| University | 21 | 6 | 27 |
| Faculty | 21 | 0 | 21 |
| Department | 65 | 21 | 86 |
| Total | 107 | 27 | 134 |

II. **Major / Minor** (86 Credit Hrs.):

(1) Major (in Physics) (65 Credit Hrs.):

a- Obligatory courses (62 Credit Hrs.):

Phys. 102, Phys. 103, Phys. 105, Phys. 106, Phys. 107, Phys. 201, Phys. 221A Phys. 225, Phys. 227, Phys. 235, Phys. 251, Phys. 253, Phys. 261, Phys. 281B, Phys. 301, Phys. 311, Phys. 312, Phys. 322, Phys. 332, Phys. 333, Phys 352, Phys. 353, Phys. 462, Math 102, Math 201.

b- Elective courses (3 Credit Hrs.): chosen from the following courses offered by the Physics Department:
Phys. 202, Phys.282, Phys. 341, Phys. 401, Phys. 433, Phys. 441, Phys. 443, Phys. 444, Phys. 446, Phys. 471, Phys. 481, Phys. 492, Phys. 499C.

(2) Minor (21 Credit Hrs.) in any Department of the Faculty of Sciences or the Faculty of Information Technology and Computer Sciences according to the minor listing of each Department.

**Table (2)**
**Major / Minor Credit Hours**

| Requirements | Obligatory | Elective | Total |
|---|---|---|---|
| University | 21 | 6 | 27 |
| Faculty | 21 | 0 | 21 |
| Department | 62 | 3 | 65 |
| Minor | | | 21 |
| Total | | | 134 |

III. **Minor in Physics** (21 Credit Hrs):

(1) Obligatory courses (15 Credit Hrs.):
Phys. 102, Phys. 103, Phys. 105, Phys. 106, Phys. 107, Phys. 251, Phys. 261.

(2 ) Elective courses (6 Credit Hrs.): chosen from the following courses:
Phys. 201, Phys. 202, Phys. 235, Phys. 253, Phys. 281B, Phys. 282, Phys. 381, Phys. 433, Phys. 492, Phys. 499C.

# Study Plan for the Bachelor's Degree in Biomedical Physics

The Physics Department at Yarmouk University offers a Bachelor Degree in Biomedical Physics on the completion of the following requirements:

1. The fulfillment of the conditions stated in the regulations of awarding the Bachelor's degree at Yarmouk University No. (2) for the year 1991 and its amendments issued in accordance with the bylaws of awarding academic degrees and diplomas at Yarmouk University No. 76 for the year 1976.
2. University course requirements stated under the above regulations.
3. Faculty of Science course requirements.
4. Department course requirements (86 Credit hrs.):
   1. Obligatory courses: (68 Credit hrs.).

      Phys. 102, Phys. 103, Phys. 105, Phys. 106, Phys. 107, Phys. 201, Phys.227, Phys. 235, Phys. 251, Phys. 306, Phys. 332, Phys. 341, Phys. 342, Phys. 343A, Phys. 352, Phys.426A, Phys. 466, Phys. 484, Phys. 498, Bio.102, Bio.105, Bio.201, Bio.251, Chem. 102, Chem.105, Chem. 215, Math 102,

2. Elective courses: (18 Credit hrs.).

   a. (12Credit hrs.) chosen from courses offered by Physics Department:
      Phys. 236, Phys. 261, Phys. 301, Phys. 311, Phys. 312, Phys. 333, Phys. 353, Phys.381, Phys.411, Phys.427, Phys.436, Phys. 441, Phys. 441A, Phys.442A, Phys.443A, Phys.467, Phys.485, Phys.486, Phys.487, Phys. 493, Phys.499A, Phys.499B, Phys.499C.

   b. (6 Credit hrs.) chosen from the following:
      Bio. 304, Bio. 333, Bio 345, Math. 201, Math. 241, Math. 321, Chem. 216, CIS 103, MIS 120, CS 130, Stat. 203.

**Table (1)**
**Biomedical Physics credit hours**

| Requirements | Obligatory | Elective | Total |
|---|---|---|---|
| University | 21 | 6 | 27 |
| Faculty | 21 | 0 | 21 |
| Department | 68 | 18 | 86 |
| Total | 110 | 24 | 134 |

**Table (3)**
**The Significance of the Second Digit**

| Num. | Title | Num. | Title |
|---|---|---|---|
| 0 | General Physics | 5 | Modern Physics, Relativity or Quanta's |
| 1 | Mechanics or Biophysics | 6 | Thermodynamics or Statistical Mechanics, or Therapy |
| 2 | Practical | 7 | Solid State |
| 3 | Electricity or Electronics, Computer | 8 | Optics, Vibrations, or Imaging |
| 4 | Atomic and Molecular, Nuclear or Elementary Particles | 9 | Seminar, Special Topics, or Training |

**Table (4)**
**Courses Offered by the Physics Department**

| No. | Course No. | Course Title | Weekly Hours | | Cr. Hrs. | Prerequisites |
|---|---|---|---|---|---|---|
| | | | Theory | Lab | | |
| 1. | Phys. 099 | General Physics | 3 | – | 3 | – |
| 2. | Phys. 100 | Fundamentals of Astronomy | 3 | – | 3 | For non-science students |
| 3. | Phys. 101 | General Physics (1)(Mechanics) | 3 | – | 3 | - |
| 4. | Phys. 102 | General Physics (2) (Electricity and Magnetism) | 3 | – | 3 | Phys. 101 |
| 5. | Phys. 103 | General Physics (3) (Waves and Light) | 3 | – | 3 | Phys. 102 |
| 6. | Phys. 104 | General Physics for IT Students | 3 | - | 3 | - |
| 7. | Phys. 105 | General Physics Laboratory (1) (Mechanics) | – | 3 | 1 | Phys. 101 or concurrent. |
| 8. | Phys. 106 | General Physics Laboratory (2) (Electricity and Magnetism) | – | 3 | 1 | Phys. 102 or concurrent. |
| 9. | Phys. 107 | General physics Laboratory (3) (Waves and Light) | – | 3 | 1 | Phys. 103 or concurrent. |
| 10. | Phys. 201 | Methods of Theoretical Physics (1) | 3 | – | 3 | Math. 102<br>Phys. 102 |
| 11. | Phys. 202 | Astronomy (1) | 3 | – | 3 | Phys. 101 |
| 12. | Phys. 203 | Astronomy (2) | 3 | – | 3 | Phys. 202 |
| 13. | Phys. 204 | Geophysics (1) | 3 | – | 3 | Phys. 103 ,<br>Geo. 101 |
| 14. | Phys. 205 | Geophysics (2) | 3 | – | 3 | Phys. 204 |
| 15. | Phys. 207 | Waves and Light | 2 | - | 2 | Phys. 102 |
| 16. | Phys. 208 | Properties of Matter | 3 | - | 3 | Phys. 102 |
| 17. | Phys. 221A | Geometrical Optics, Laboratory | – | 3 | 1 | Phys. 281B or concurrent. |
| 18. | Phys. 223 | General Physics Laboratory (Waves and Light) | – | 3 | 1 | Phys. 207 or concurrent. |
| 19. | Phys. 225 | Classical Physics Laboratory | – | 3 | 1 | Phys. 103 or concurrent. |
| 20. | Phys. 227 | Electronics Laboratory | – | 3 | 1 | Phys. 235 or concurrent |
| 21. | Phys. 234 | Basics of Computational Physics | 3 | – | 3 | CS. 101 |
| 22. | Phys. 235 | Electronics (1) | 3 | | 3 | Phys. 102,<br>Phys. 106 |
| 23. | Phys. 236 | Electronics (2) | 3 | - | 3 | Phys. 235 |
| 24. | Phys. 251 | Modern Physics (1) | 3 | – | 3 | Phys. 103 |
| 25. | Phys. 253 | Modern Physics (2) | 3 | – | 3 | Phys. 251 |
| 26. | Phys. 261 | Thermodynamics | 3 | | 3 | Phys. 101,<br>Math. 102 |

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|---|---|---|---|---|---|---|
| 27. | Phys. 281A | Geometrical Optics | 2 | - | 2 | Phys. 207 |
| 28. | Phys. 281B | Geometrical Optics | 3 | – | 3 | Phys. 103 |
| 29. | Phys. 282 | Vibrations and Waves | 3 | – | 3 | Phys. 103,<br>Phys. 201 |
| 30. | Phys. 301 | Methods of Theoretical Physics (2) | 3 | – | 3 | Phys. 201 |
| 31. | Phys. 303 | Space Physics | 3 | – | 3 | Phys. 103 |
| 32. | Phys. 304 | Astrophysics | 3 | – | 3 | Phys. 201 |
| 33. | Phys. 305 | Meteorology | 3 | – | 3 | Phys. 201 |
| 34. | Phys. 306 | Introduction to Biomedical Physics | 3 | - | 3 | Phys. 201 , Phys. 251 |
| 35. | Phys. 311 | Classical Mechanics (1) | 3 | – | 3 | Phys. 201 |
| 36. | Phys. 312 | Classical Mechanics (2) | 3 | – | 3 | Phys. 311 |
| 37. | Phys. 322 | Junior Physics Laboratory (1) | – | 4 | 2 | Phys. 107,<br>Phys. 251 |
| 38. | Phys. 323 | Junior Physics Laboratory (2) | – | 4 | 2 | Phys. 322 |
| 39. | Phys. 332 | Electromagnetic Theory (1) | 3 | – | 3 | Phys. 201 |
| 40. | Phys. 333 | Electromagnetic Theory (2) | 3 | – | 3 | Phys. 332 |
| 41. | Phys. 334 | Chaos | 3 | – | 3 | Phys. 201 |
| 42. | Phys. 341 | Radiation Physics | 3 | – | 3 | Phys. 201, Phys 251 |
| 43. | Phys. 342 | Radiation Biophysics | 3 | - | 3 | Phys. 341 |
| 44. | Phys. 343A | Health Physics | 3 | - | 3 | Phys. 341 |
| 45. | Phys. 352 | Quantum Mechanics (1) | 3 | – | 3 | Phys. 201,Phys. 251 |
| 46. | Phys. 353 | Quantum Mechanics (2) | 3 | – | 3 | Phys. 352 |
| 47. | Phys. 361 | Thermal and Statistical Physics | 3 | – | 3 | Phys. 261 |
| 48. | Phys. 381 | Biomedical Optical Spectroscopy | 3 | - | 3 | Phys. 103 |
| 49. | Phys. 401 | Methods of Theoretical Physics(3) | 3 | – | 3 | Phys. 301 |
| 50. | Phys. 411 | Biophysics | 3 | - | 3 | Phys. 306 |
| 51. | Phys. 413 | Elements of Continuum Mechanics | 3 | – | 3 | Phys. 312 |
| 52. | Phys. 423 | Advanced Physics Laboratory (1) | 1 | 4 | 3 | Phys. 322 |
| 53. | Phys. 424 | Advanced Physics Laboratory (2) | – | 6 | 3 | Phys. 322 |
| 54. | Phys. 426 | Medical Imaging Lab | - | 3 | 1 | Phys. 484 |
| 55. | Phys 426A | Medical Physics Lab (1) | - | 4 | 2 | Phys. 484 |
| 56. | Phys. 427 | Medical Physics Lab (2) | - | 4 | 2 | Phys. 484 |
| 57. | Phys. 432 | Microprocessor Applications | 2 | 3 | 3 | Phys. 236 |
| 58. | Phys. 433 | Computer Methods and Techniques in Physics | 2 | 3 | 3 | CS. 101 |
| 59. | Phys. 436 | Bio-Computational Modeling | 2 | 3 | 3 | CS. 101, Phys. 341 |

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|---|---|---|---|---|---|---|
| 60. | Phys. 441 | Nuclear Physics (1) | 3 | – | 3 | Phys. 352 |
| 61. | Phys. 441A | Physics of Nuclear Medicine | 3 | - | 3 | Phys. 341 |
| 62. | Phys. 442 | Nuclear Physics (2) | 3 | – | 3 | Phys. 441 |
| 63. | Phys. 442A | Radiation Detection and Measurements | 3 | - | 3 | Phys. 341 |
| 64. | Phys. 443 | Atomic and Molecular Physics | 3 | – | 3 | Phys. 352 |
| 65. | Phys. 443A | Radiation Protection and Dosimetry | 3 | - | 3 | Phys. 341 |
| 66. | Phys. 444 | Elementary Particle Physics | 3 | – | 3 | Phys. 352 |
| 67. | Phys. 445 | Physics of Spectroscopy | 3 | – | 3 | Phys. 352 |
| 68. | Phys. 446 | Plasma Physics | 3 | – | 3 | Phys. 311, Phys. 332 |
| 69. | Phys. 451 | Theory of Special Relativity | 3 | – | 3 | Phys. 311, Phys. 332 |
| 70. | Phys. 462 | Statistical Mechanics | 3 | – | 3 | Phys. 352, Phys. 261 |
| 71. | Phys. 466 | Radiation Therapy (1) | 3 | - | 3 | Phys. 306, Phys. 342 |
| 72. | Phys. 467 | Radiation Therapy (2) | 3 | - | 3 | Phys. 466 |
| 73. | Phys. 471 | Solid State Physics (1) | 3 | – | 3 | Phys. 352 |
| 74. | Phys. 472 | Solid State Physics (2) | 3 | – | 3 | Phys. 471 |
| 75. | Phys. 481 | Physical Optics | 3 | – | 3 | Phys. 281B |
| 76. | Phys. 482 | Laser Physics | 3 | – | 3 | Phys. 481 or concurrent. |
| 77. | Phys. 484 | Medical Imaging (1) | 3 | - | 3 | Phys.306, Phys.341 |
| 78. | Phys. 485 | Medical Imaging (2) | 3 | - | 3 | Phys.484 |
| 79. | Phys. 486 | Magnetic Resonance Imaging (MRI) | 3 | - | 3 | Phys.484 |
| 80. | Phys. 487 | Image Processing and Analysis | 3 | - | 3 | Phys.484 |
| 81. | Phys. 491 | Seminar | 1 | – | 1 | 4th year level |
| 82. | Phys. 492 | Special topics | 3 | - | 3 | Department approval |
| 83. | Phys. 493 | Special Topics in Medical Physics | 3 | - | 3 | Department approval |
| 84. | Phys. 498 | Practical Training | - | 12 | 3 | Phys. 466,<br>Phys. 484 |
| 85. | Phys. 499A | Project | 1 | - | 1 | Department approval |
| 86. | Phys. 499B | Project | 2 | - | 2 | Department approval |
| 87. | Phys. 499C | Project | 3 | - | 3 | Department approval |

## Course Description of the Department of Physics Courses for the Bachlor Degree

**Phys. 099 – General Physics (3 credit hrs.)**
Vectors, Dynamics, Types of motions, Newton's laws of motion, Work and Energy, Linear momentum, Static electricity, Electric currents and Electric circuits, Magnetic field, Electromagnetic induction, Static Fluid Mechanics, Mobile Fluid Mechanics, Mechanical Properties of Matter.

**Phys. 100 - Fundamentals of Astronomy (3 credit hrs.)**
Ancient astronomy, modern astronomy, astronomical equipments. The earth: motions, composition and atmosphere, locating places on earth, the celestial coordinates, view of the sky from different places, the movements of the sun, the movements of the moon, lunar and solar eclipse, tides, the solar system, calendars and time, time and date transformation, prayer time. The universe: creation, development, and fate.

**Phys. 101 - General Physics (1) (Mechanics) (3 credit hrs.)**
Measurement and system of units, vectors, motion in one and two dimensions, particle dynamics and Newton's laws of motion, work and energy, conservation of energy, dynamics of system of particles, center of mass, conservation of linear momentum, collisions, impulse, rotational kinematics, rotational dynamics, conservation of angular momentum, elasticity, fluids.

**Phys. 102 - General Physics (2) (Electricity and Magnetism) (3 credit hrs.)**
Charge and matter, electric field, gauss's law, electric potential, capacitors and dielectrics, current and resistance, electromotive force and circuits, the magnetic field, ampere's law, faraday's law of induction, Maxwell's equations; magnetic properties of matter, A.C. circuits.

**Phys. 103 – General Physics (3) (Waves and Light) (3 credit hrs.)**
Mechanical oscillations, electromagnetic oscillations, LC Circuits, transverse and longitudinal waves, electromagnetic waves and polarization, interference, diffraction.

**Phys. 104 – General Physics for IT Students (3 credit hrs.)**
Units, Vectors, Motion in one and two dimensions, Newton's laws, Work-Energy Theorem, Conservation of Energy, Momentum and conservation of Momentum, Newton's second law in rotational motion and angular momentum, Charge, Coulomb law, Electric field, Electric potential and electric potential energy, Capacitors, Conductors and insulators, Simple circuit and multi-loop circuits, Magnetic field and magnetic induction, Atom and atomic nucleus, Bohr atom and radiative transitions, The solid state and crystalline structure, Energy bands, Semiconductors, pnp and npn junctions, Diodes, light-emitting diodes, bipolar transistors and MOSFET, Fabrication of Integrated Circuits, Dynamic Random-Access Memory (DRAM),Fundamentals of solar cells, Charged-coupled-device imaging arrays, Heterostructure lasers

**Phys. 105 - General Physics Laboratory (1) (Mechanics) (1 credit hrs., 3 exp.)**
Experiments on statics, motion, free fall and projectiles, force and motion, Newton's laws, friction, rotational motion, work, conservation of energy, linear momentum, moment of inertia.

**Phys. 106 - General Physics Laboratory (2) (1 credit hrs., 3 exp.)**
**(Electricity and Magnetism)**
Experiments on Galvanometer and its uses, Ohm's law, electric field, electric potential 1, capacitor, Wheatstone bridge, potentiometer, electromotive force, Kirchoff's laws, RLC-circuits.

**Phys. 107 - General Physics Laboratory (3) (Waves and Light) (1 credit hrs., 3 exp.)**
Experiments covering the topics discussed in Phys. 207A: Mechanical vibrations, speed of mechanical waves, speed of sound, vector diagram of RLC circuit, resonance in RLC circuit, Geometrical optics, polarization of light, Young double-slit experiment, Franhofer diffraction.

**Phys. 201 - Methods of Theoretical Physics (1) (3 credit hrs.)**
Vector analysis, curvilinear coordinates, complex numbers, determinants and matrices, first and second order differential equations, Fourier series.

**Phys. 202 - Astronomy (1) (3 credit hrs.)**
Nature of astronomy, historical background, Light and electromagnetic radiation, Telescopes and observatories, The solar system (The Sun, The earth and its moon, Other planets).

**Phys. 203 - Astronomy (2) (3 credit hrs.)**
Stars (motion, distance, brightness, absolute magnitude, temperature, size), multiple star systems, variable stars, the interstellar medium, the birth and life of stars, the death of stars (White dwarf, neutron stars, pulsars, black holes), milky way & other galaxies, the universe.

**Phys. 204 - Geophysics (1) (3 credit hrs.)**
General survey of terrestrial geophysics including the earth's seism city, internal structure, shape, gravity, magnetic field, pale magnetism, heat flow and global tectonics.

**Phys. 205 - Geophysics (2) (3 credit hrs.)**
Theory of electricity and Magnetism, gravity, seismic retraction and reflection exploration methods.

**Phys. 207 – Waves and Light (2 credit hrs.)**
Mechanical oscillations, electromagnetic oscillations, LC Circuits, transverse and longitudinal waves, electromagnetic waves and polarization, interference, diffraction.

**Phys. 208 - Properties of Matter (3 credit hrs.)**
Introduction to phases of matter, elasticity, microscopic study, atomic, molecular and crystal structure, thermal properties and kinetic theory, optical properties, fluid statics, fluid dynamics, continuity equation and Bernoulli equation and applications.

**Phys. 221A - Geometrical Optics Laboratory (1) (1 credit hrs., 3 exp.)**
Experiments on: Focal length measurements of thin lenses and spherical mirrors, the telescope, prisms, transmission and reception using fiber lines, glass optical fibers, irradiation measurements, velocity of light, fabrication of simple optical devices.

**Phys. 223 - General Physics Laboratory (Waves and Light) (1 credit hrs., 3 exp.)**
Experiments covering the topics discussed in Phys. 207A: Mechanical vibrations, speed of mechanical waves, speed of sound, vector diagram of RLC circuit, resonance in RLC circuit, Geometrical optics, polarization of light, Young double-slit experiment, Franhofer diffraction.

**Phys. 225 - Classical Physics, Laboratory (1 credit hrs., 3 exp.)**
10 experiments in Mechanics, heat and fluids: Archimedes principle, pressure of liquids, surface tension, coefficient of viscosity, gas thermometer, specific heat, linear and volume expansions, mechanical equivalent of heat, thermal equivalent of electrical energy.

**Phys. 227 - Electronics Laboratory (1 credit hrs., 3 exp.)**
Experiments on semi-conductors, transistors, voltage regulators and filters, rectifiers, amplifiers, timers, and wave form generators.

**Phys. 234 - Basics of Computational Physics (3 credit hrs.)**
Introduction to computers, operating systems, programming languages, fundamental mathematical operations; applications: newtonian mechanics, Kepler's laws; wave phenomena: interference and diffraction, simple harmonic oscillator, a quantum problem.

**Phys. 235 - Electronics (I) (3 credit hrs.)**
D.C Circuits, A.C circuits, Semiconductors, Diode Theory, Diode Circuits and Special Purpose diodes. Bipolar Transistors, Transistor Fundamentals and Transistor Biasing, Voltage amplifier, Power Amplifiers, Field Effect Transistors and Circuits, Op-Amp Theory, Op-Amp circuits and Applications, Oscillators, The 555 Timer.

**Phys. 236 - Electronics (II) Digital electronics (3 credit hrs.)**
Introduction, Digital Logic, combinational Logic, Applications of combinational Logic, Integrated circuits, Technologies, sequential Logic, Synchronous Logic, Memory and Storage, Interfacing.

**Phys. 251 - Modern Physics (1) (3 credit hrs.)**
Theory of special relativity, dual property of light and particles, atomic structure, Schrödinger equation and some application, ideal hydrogen atom.

**Phys. 253 - Modem Physics (2) (3 credit hrs.)**
This course includes basic concepts about topics in modern physics in the following fields: many electron atoms, molecular structure, solid state, nuclear Physics and elementary particles.

**Phys. 261 - Thermodynamics (3 credit hrs.)**
Fundamental concepts, equations of state, the First Law of thermodynamics, entropy and the Second Law of thermodynamics, thermodynamic potentials.

**Phys. 281A - Geometrical Optics (2 credit hrs.)**
Reflection and refraction at plane surfaces, mirrors and Lenses, image formation applications, aberrations, (types of aberrations), matrix algebra in optics, prisms (types of prisms) & dispersion of light by prisms, optical fibers (definition and types, applications), Radiometry, photometry, radiance and irradiance, luminescence instrumentation, speed of light measurement by astronomical and terrestrial methods.

**Phys. 281B - Geometrical Optics (3 credit hrs.)**
Reflection and refraction at plane surfaces, mirrors and Lenses, image formation applications, aberrations, (types of aberrations), matrix algebra in optics, prisms (types of prisms) & dispersion of light by prisms, optical fibers (definition and types, applications), Radiometry, photometry, radiance and irradiance, luminescence instrumentation, speed of light measurement by astronomical and terrestrial methods.

**Phys. 282 - Vibrations and Waves (3 credit hrs.)**
Forced and coupled Oscillations, motion of longitudinal waves, transverse wave in transmission lines, electromagnetic waves, wave motion in 2-dimensions or more, Fourier method, diffraction and interference.

**Phys. 301 - Methods of Theoretical Physics (2) (3 credit hrs.)**
Gamma and Beta Functions, Dirac-delta function, series solution of differential equations, Sturm-Liouville eigenvalue problem, Bessel functions, Legendre functions, spherical harmonics, angular momentum operators, radial equations of the hydrogen atom, harmonic oscillator.

**Phys. 303 - Space Physics (3 credit hrs.)**
Particle dynamics, earth satellite operations, rigid body dynamics, satellite altitude dynamics, gyroscopic instruments, rocket performance, reentry dynamics, the space environment, interplanetary trajectories.

**Phys. 304 – Astrophysics (3 credit hrs.)**
Atomic and nuclear spectra, gas laws, radiation laws, stellar luminosity, line profiles, spectral classes, stellar interior, stellar structure, star formation, stellar evolution, transport process in star.

**Phys. 305 - Meteorology (3 credit hrs.)**
Fundamental concepts, the fundamental equations of meteorology, simple manipulation with the fundamental equation, the method of perturbations, dynamic forecasting.

**Phys. 306 - Introduction to Biomedical Physics (3 credit hrs.)**
Biomechanics. Biofluid mechanics. sound and hearing. light and vision. Heat and temperature, electricity and magnetism in the body. Biomagnetism. The use of ionizing and non ionizing radiation in diagnosis and therapy. radiation safety.

**Phys. 311 - Classical Mechanics (1) (3 credit hrs.)**
Elements of Newtonian mechanics, motion in one, two and three dimensions, motion of a system of particles, motion of rigid bodies, gravitation, moving coordinate systems.

**Phys. 312 - Classical Mechanics (2) (3 credit hrs.)**
Quick review of statics, Lagrange equations, Hamilton equations, tensor algebra, rotational dynamics of rigid bodies, theory of small oscillations.

**Phys. 322 - Junior Physics Laboratory (1) (2 credit hrs., 4 exp.)**
10 experiments in modern physics, quantum physics and atomic physics: Frank – Hertz experiment, black body radiation, Gieger–Muller tube 1, Millikan oil drop, electron diffraction, e/m, diffraction grating, Hall effect, Gieger–Muller tube 2, x-ray diffraction.

**Phys. 323 - Junior Physics Laboratory (2)** **(2 credit hrs., 4 exp.)**
Zeeman effect, electron Spin resonance, nuclear magnetic resonance, Michelson experiment, microwave experiment, optical activity.

**Phys. 332 - Electromagnetic Theory (1)** **(3 credit hrs.)**
Quick review of vector analysis and electrostatics, solution of electrostatic problems in vacuum and in dielectric media, electrostatic energy, magnetic field of steady currents, magnetic properties of matter.

**Phys. 333 - Electromagnetic Theory (2)** **(3 credit hrs.)**
Electromagnetic induction, magnetic energy, Maxwell's equations, propagation of electromagnetic waves, polarization, reflection and refraction of EM waves, wave guides, radiation emission.

**Phys. 334 - Chaos** **(3 credit hrs.)**
Introduction, identification chaos, models for Chaos, chaos in physical systems, criteria for chaos, fractals and dynamical systems, spatiotemporal chaos.

**Phys. 341 - Radiation Physics** **(3 credit hrs.)**
Fundamentals of radiation physics: radioactivity and decay kinetics; sources of ionizing radiation, natural decay series; production and properties of ionizing radiation; interactions of photons, charged particles, and neutrons with matter; radiation detectors; concepts of radiation dosimetry (theoretical and experimental, cavity theory and ionization chambers).

**Phys. 342 Radiation Biophysics** **(3 credit hrs.)**
Effects of radiation on living cells and organisms (cytoxcity, mutagenecity, and carcenogesis), theories and models of cell survival, survival curve and its significance, modification of radiation response, delayed effects and dose-effect relationship، genetic effects of ionizing radiation, direct and indirect effects.

**Phys. 343A - Health Physics** **(3 credit hrs.)**
Review of the sources of radiation, basic dosimetry, and hazards of ionizing radiation, Radiation safety guides and codes in the environment, industry, medical and nuclear facilities, Techniques for the detection, use, and safe handling of radiation sources, Radiation protection and shielding: monitoring of sources, planning of facilities, waste management, and radiation protection for the public, radiation detection and counting statistics. Radiation laws and regulating agencies,

**Phys. 352 - Quantum Mechanics (1)** **(3 credit hrs.)**
Wave packets and the uncertainty relations, Schrödinger equation, eigenfunctions and eigenvalues, potentials in one-dimension, structure of wave mechanics, operator methods in Q.M., Schrödinger equation, in three dimensions, angular momentum, Ideal hydrogen atom.

**Phys. 353 - Quantum Mechanics (2)** **(3 credit hrs.)**
Review of ideal hydrogen atom, Interaction of electrons with magnetic fields, operators and spin using matrices, addition of angular momentum and spin, theories of time-independent approximation methods, real hydrogen atom, helium atom, scattering theory, theories of time-dependent approximation methods.

**Phys. 361 - Thermal and Statistical Physics (3 credit hrs.)**
Fundamental concepts, equations of state, the first Law of thermodynamics, the Energy equation, entropy and the second Law of thermodynamics, thermodynamic potentials, statistical thermodynamics, applications of statistics to gases and other systems

**Phys. 381 - Biomedical Optical Spectroscopy (3 credit hrs)**
The theoretical and experimental principles underlying the application of optical spectroscopy in medical and biological physics. Use of lasers and fiber optics in medicine for diagnosis and therapy.

**Phys. 401 - Methods of Theoretical Physics (3) (3 credit hrs.)**
Tensors, group theory, hyper geometric function, integral transforms, complex variables, calculus of variations.

**Phys. 411 - Biophysics (3 credit hrs.)**
Molecular structure of biomolecules. properties and function of proteins, nucleic acids, lipids and membranes. Energetics and dynamics of biological systems. Physical aspects of selected systems including: Vision, nerve transmission, photosynthesis, enzyme mechanism, and cellular diffusion. Introduction to spectroscopic methods for monitoring reactions and determining structure including light absorption or scattering, fluorescence, NMR, and x-ray diffraction.

**Phys. 413 - Elements of Continuum Mechanics (3 credit hrs.)**
Tensor Calculus. Space of vectors, vector algebra, basis and its reciprocal, transformation of basis, second -rank tensors, operations with second-rank tensors, symmetrical and antisymmetrical second-rank tensors, higher-rank tensors, groups of tensor symmetry, tensor fields. Kinematics of continuous medium, dynamics of continuum, constitutive equations (Euler equation, Newtonian fluid equation, Stokes., .. ), some examples and problems.

**Phys. 423 - Advanced Phys. Laboratory (1) (3 credit hrs., 1 theo. 4 exp.)**
Optical activity, measurement of index of refraction of air and the wavelength of a light source using Michelson interferometer, Zeeman effect, nuclear magnetic resonance, reflection and refraction (using microwave) Bragg law (using microwave), measurement of the length of a wave from a microwave source (using Michelson's interferometer) analysis of elementary particles tracks after collision.

**Phys. 424 - Advanced Physics Laboratory (2) (3 credit hrs., 6 exp.)**
**(Nuclear and solid state)**
Instrumentation, x-ray spectroscopy, alpha-particles spectroscopy, beta-particles spectroscopy, coincidence technique and positron decay.

**Phys. 426 - Medical Imaging Lab (1 credit hrs., 3 exp.)**
Experiments in Medical imaging and Radiation physics: These include X-ray imaging, NMR, gamma-ray spectroscopy, attenuations and statistics of radiation.

**Phys. 426A - Medical Physics Lab (1) (2 credit hrs., 4 exp.)**
Experiments in Medical imaging and Radiation physics: These include X-ray imaging, NMR, gamma-ray spectroscopy, attenuations and statistics of radiation.

**Phys. 427 - Medical Physics Lab (2)** **(2 credit hrs., 4 exp.)**
Advanced experiments in Medical imaging and Radiation physics: These include digital imagining (image processing and analysis) and advanced gamma-ray spectroscopy.

**Phys. 432 - Microprocessor Applications** **(3 credit hrs.)**
Signals representing physical quantities, transducers, signal processing and conditionings, voltage to frequency converters, digital to analogue converters, analog to digital converters, data acquisition systems using microprocessors, using computers in data acquisition, presentation and analysis, measurement of some various physical quantities.

**Phys. 433 - Computer Methods and Techniques in Physics** **(3 credit hrs., 2theo., 3 exp.)**
Operating systems: utilities and shell programming, compilers and developer utilities, numerical libraries and their interfaces, numerical analysis: roots of a function, interpolation and extrapolation, data fitting, numerical integration and differentiation, solution of a system of linear equations, solution of differential equations and partial differential equations, boundary value problems, special functions used frequently in physics, Monte Carlo and quantum Monte Carlo simulations. Application in various branches of physics: quantum, atomic, classical mechanics, classical electrodynamics and statistical mechanics.

**Phys. 436 - Bio-Computational Modeling** **(3 credit hrs., 2theo., 3 exp.)**
Biological background and developmental strategy of mathematical models of tissue response in cancer treatments and cancer research. Computational methods for dose distribution calculations. Linear quadratic, TCP and NTCP models and examples of their use.

**Phys. 441 - Nuclear Physics (1)** **(3 credit hrs.)**
Review, Nuclear Properties, nuclear force, nuclear models, nuclear radioactivity, alpha-decay, beta-decay, gamma-decay, nuclear reactions (fission and fusion), applications.

**Phys. 441A Physics of Nuclear Medicine** **(3 credit hrs.)**
Discussion of the fundamental physics of radioactivity, the use of unsealed sources in medical diagnosis and treatment. Unsealed source dosimetry, nuclear measurement instrumentation, spectrometry. Design and function of gamma cameras, single photon emission tomography (SPECT), and double photon (positron) emission tomography (PET), instruments quality assurance, counting statistics.

**Phys. 442 - Nuclear Physics (2)** **(3 credit hrs.)**
The shell model, nuclear deformation and the unified model, electromagnetic interaction, the weak interaction, the strong interaction.

**Phys. 442A – Radiation Detection and Measurement** **(3 credit hrs.)**
Production of radioisotopes, their safe handling, the proper design of radiotracer experiments, the theory and operation of radiation detection instrumentation, error analysis, and the statistical methodology underlying the quantification of radioactivity.

**Phys. 443 -Atomic and Molecular Physics** **(3 credit hrs.)**
Hydrogen atom and angular momentum theory, complex atoms and effects o f spin, the Wigner-Eckart theorem, selection rules, external fields, molecular spectra and Hund's coupling cases, effects of spin and Wigner-Witmer correlation rules.

**Phys. 443A - Radiation Protection and Dosimetry (3 credit hrs.)**
Radiation dosimetry quantities, fundamentals of gamma ray and neutron attenuation, calculational and experimental methods for assessing the absorbed dose, effective dose assessment, committed effective dose assessment, approximate methods of shield design, external and internal dosimetry and radiation risk assessment.

**Phys. 444 - Elementary Particle Physics (3 credit hrs.)**
General review about the nature of the elementary particles and forces in nature, addition of angular momentum, relativistic kinematics, conservation laws and symmetry principles, intrinsic quantum numbers, nucleons interaction with mesons, classification of elementary particles, quark model and its applications.

**Phys. 445 – Physics of Spectroscopy (3 credit hrs.)**
Characteristics and techniques for measurement of spectra from radiofrequency through microwaves, infrared, visible, ultra-violet and shorter wavelengths, applications to atomic, molecular and solid state physics, spectroscopic methods using tunable lasers as high resolution saturation spectroscopy, two and multi-photon spectroscopy and nonlinear mixing of coherent waves.

**Phys. 446 - Plasma Physics (3 credit hrs.)**
Basic treatment of the plasma state via the Boltzmann equation, including collisions, derby shielding length, diffusion, conductivity, oscillation and propagation of EM waves.

**Phys. 451 - Theory of Special Relativity (3 credit hrs.)**
Historical introduction: the conceptual implications of Newtonian mechanic and gravity, the conceptual implications of Maxwell EM theory, Galilean invariance and Lorentz invariance, the Einstein two postulates, Implications of Lorentz transformations, The relativity of simultaneity, four-vectors: linear momentum and mass-energy equivalence, invariance of the spacetime interval, proper time, space-like and time-like intervals, The Minkowski spacetime, The light cone, Maxwell equations in four-vector forms, Relativistic mechanics of charged particles, Relativistic Doppler effect and optical applications.

**Phys. 462 - Statistical Mechanics (3 credit hrs.)**
Maxwell-Boltzmann statistics and its applications, Bose-Einstein statistics, Fermi-Dirac statistics, statistical concepts of temperature and entropy, thermodynamics of gases, application of statistical thermodynamics, the canonical ensemble, the grand canonical ensemble .

**Phys. 466 - Radiation Therapy (1) (3 credit hrs.)**
Production, interaction, and dosimetry of high-energy x-rays and electrons, LINAC theory, radiation dose distribution and treatment planning, brachytherapy physics: use of radionuclides sources for radiation therapy, materials used, source construction, dosimetry theory and practical applications. Therapeutic applications of non-ionizing radiation.

**Phys. 467 - Radiation Therapy (2) (3 credit hrs.)**
Advanced aspects of radiation therapy with emphasis on external beam dosimetry, 3D treatment planning, and simulation. Proton therapy and Heavy ion therapy, IMRT.

**Phys. 471 - Solid State Physics (1) (3 credit hrs.)**
Crystal structure and binding, diffraction in crystals, reciprocal lattice and vibrations, photons and specific heat, free electron model.

**Phys. 472 - Solid State Physics (2) (3 credit hrs.)**
Band theory of solids, semiconductors, dielectric and ferroelectric properties, magnetic, properties of solids, optical phenomena in solids, superconductivity.

**Phys. 481 - Physical Optics (3 credit hrs.)**
Brief history of optics, mathematics of wave motion, electromagnetic theory of light, Fresnel coefficients, optics of thin films, polarization, nature of polarized light, polarizer's, diachronism, birefringence, retarders, faraday rotation, Kerr effect, optical activity, john matrices, interference of two beams, interference of more than two beams, Mich. interferometer, Fabry-Perot interferometer, diffraction, theory of diffraction, diffraction from slits and apertures, diffraction gratings.

**Phys. 482 - Laser Physics (3 credit hrs.)**
Introduction, theory of three and four levels lasers, types of lasers, solid state lasers, gas laser, diode lasers & examples. cavities of laser, stability of laser cavity using matrix optics. Optics of Gaussian beam, theory of pulsed lasers for three and four levels lasers. selection of wavelength of laser using dispersion elements like: Prisms, Fabry - Perot, birefringence plates .... etc. Non-linear optics and harmonic generation. application of lasers.

**Phys. 484 - Medical Imaging (1) (3 credit hrs.)**
Mathematical and statistical aspects of imaging science, Physical description of image quality: resolution, contrast, and signal to noise ratio. X-ray imaging: radiography, fluoroscopy, and computed tomography (CT). Nuclear medicine imaging. Magnetic resonance imaging (MRI). Ultrasound physics.

**Phys. 485 - Medical Imaging (2) (3 credit hrs.)**
Evaluation and optimization of imagining systems (x-ray CT, MRI, Nuclear Medicine, and Ultrasonic imaging). Linear system theory in the Fourier domain. Image processing and analysis. Statistical properties of signals. Quality assurance. Practical applications. Introduction to digital imaging: digital x-rays and digital subtraction angiography (DSA).

**Phys. 486 Magnetic Resonance Imaging (MRI) (3 credit hrs.)**
Physics and technology of magnetic resonance imaging (MRI), emphasizing techniques employed in medical diagnostic imaging. Major topics: physics of MR, pulse sequences, hardware, imaging techniques, artifacts, and spectroscopic localization.

**Phys. 487 Image Processing and Analysis (3 credit hrs.)**
Introduction to digital Image representation, digital image fundamentals, image transforms: Discrete Fourier Transform & Fast Fourier Transform, Hotelling Transform & Hough Transform. Image Enhancement; smoothing, sharpening, & model based enhancement. Image Restoration, Image encoding, and image segmentation. Introduction to 3D Visualization.

**Phys. 491 - Seminar** **(1 credit hrs.**

**Phys. 492 - Special Topics** **(3 credit hrs.)**

**Phys. 493 - Special Topics in Medical Physics** **(3 credit hrs.)**

**Phys. 498 - Practical Training** **(3 credit hrs.)**
In field training in the medical facilities in the area on the different aspects of biomedical physics.

**Phys. 499 – (A,B,C) Project** **(1-3 credit hrs.)**