B.Sc. Semester - III

DSCC-5: Physics (Theory) V (Code: 033PHY011)

Course No.5 (Theory): Title of the Course (Theory): Wave Motion and Optics

Total Hrs: 56

Unit-I: Wave Motion

Wave Motion: Types of waves, Plane and spherical waves, Transverse and longitudinal wave. Displacement, velocity and pressure curve. Expression for a plane progressive wave, particle velocity. Relation between particle velocity and wave velocity. Differential equation of wave motion, mention of differential equation of three-dimensional wave. Derivation of energy density of a plane progressive wave. Distribution of energy in a plane progressive wave. Expression of intensity of progressive wave. Superposition of waves: Interference-Beats, theory of beats(analytical treatment). Super position of two perpendicular SHM: Lissajous figures with equal and unequal frequency- analytical treatment and use of Lissajous figures. Velocity of transverse wave along stretched string, wave equation for transverse wave in a string. Longitudinal (sound) waves in fluid medium -derivation of Newton's formula - Laplace's corrections for Newton's formula. Effect of pressure, temperature and humidity on the velocity of sound. Group velocity-its relationship with wave (or phase) velocity. Concept of resonance. Theory of Helmholtz resonator.

Suggested Activities: please refer foot note **14 hrs**

Unit-II: Geometrical Optics

Fermat principle: Derivation of laws of reflection and refraction, sign convention, refraction at a spherical surface, derivation of Lagrange's law and Helmholtz relation, Abbe's sine condition derivation, aplanatic points of a spherical surface(qualitative).

Aberrations: Spherical aberrations**:** methods to reduce spherical aberration (qualitative). Chromatic aberrations: Conditions for achromatism of two thin lenses in contact, two thin lenses separated by finite distance.

Cardinal points: Cardinal points of a optical system. Equivalent focal length of two thin lenses separated by a distance. Location of cardinal points of a thick lens (derivation). Experimental determination of cardinal points of a lens system using Searle's Goniometer and Turn Table (Nodal slide).

Suggested Activities: please refer foot note **14 hrs**

Unit-III: Interference

Interference due to division of wave front: Fresnel's biprism. Determination of wavelength of monochromatic light & thickness of a thin film using biprism. Lloyd's single mirror: Determination of wavelength using Lloyd's single mirror.

Interference due to division of amplitude: Interference phenomenon with a plane parallel thin film: in case of reflected light and transmitted light (with derivation). Interference using wedge shaped film. Theory of Newton's rings. Determination of wavelength of monochromatic light by Newton's rings. Michelson interferometer: Principle, construction and working. Formation of circular & straight fringes (qualitative). Mention applications of Michelson's Interferometer.

Suggested Activities: please refer foot note **14 hrs**

Unit-IV: Diffraction and Polarization

Introduction to diffraction and classification of diffraction phenomena.

Fresnel diffraction: Fresnel's treatment of the wavefront and Fresnel assumptions. Theory of half period zones considering plane wave fronts. Zone plate: construction, theory and expression for focal length. Comparison between zone plate and convex lens.

Fraunhofer diffraction: Fraunhofer diffraction at a single slit and at a double slit. Diffraction grating. Theory of Plane transmission grating. Dispersive power of grating. Comparison of grating and Prism spectra.

Polarization: Review of basics of polarization. Malus law. Huygen's theory of double refraction. Positive and negative crystals. Wave plates: quarter wave plate and half wave plate. Optical activity, specific rotation. Laurent's Half Shade Polarimeter: Construction and working.

Suggested Activities: please refer foot note **14 hrs**

Books Recommended.

1. The Physics of Waves and Oscillations by N. K.. Bajaj Tata McGraw-Hill., 1984.
2. Waves and Oscillations by N. Subramanyam and Brij Lal Vikas Publishing House Pvt. Ltd
3. A Text Book of Sound D R Khanna and R S Bedi Atma Ram & Sons, Third Edition 1952
4. Oscillations and Waves by Satya Prakash Pragathi Prakashan, Meerut, Second Edition 2003
5. Optics by Ajoy Ghatak McGraw Hill Education (India) Pvt Ltd 2017
6. A text Book of Optics by Brij Lal, M N Avadhanulu & N Subrahmanyam S. Chand Publishing 2012
7. Mechanics by D. S. Mathur P. S. Hemne S. Chand Publishing 2012
8. Berkeley Physics Course – Waves, Frank S Crawford Jr Tata Mc Graw-Hill 2011
9. Optics Eugene *Hecht* Pearson Paper back 2019
10. Introduction To Optics Pedrotti and Frank L Pearson India 3rd Edition
11. Fundamentals of Optics Francis Jenkins Harvey White McGraw Hill Education 2017
12. Geometrical Optics (I-Edition) – D. P. Acharya – Oxford & IBH Pub. Co., New-Delhi, 1970.
13. Geometrical Optics – A. Verstraeten. Publisher: Bombay Orient Longmans 1961
14. Optics & Spectroscopy (VI-Edition) Murugeshan, Kirutiga & Shivaprasath - S. Chand & Company.

Pedagogy: Problem solving, seminar, presentation, activities, group discussion, field visit etc.,

B.Sc. Semester– III

DSCC-6: Physics (Practical) - VI **Code: 033PHY012**

Title of the Course (Practical): Wave Motion and Optics

List of the Experiments for 52 hrs / Semesters

1. Velocity of sound through wire using Sonometer.
2. Study of Lissajous Figures.
3. Helmholtz resonator using tuning fork/electrical signal generator.
4. Calibration of a spectrometer.
5. Dispersive curve and dispersive power of a prism.
6. Polarimeter: Determination of specific rotation of sugar solution
7. Study of elliptically polarized light/Verification of Malus law
8. Goniometer.
9. Turn table.
10. Newton's rings.
11. Resolving power of grating.
12. Determination of wavelength of monochromatic light using biprism/Lloyd's mirror.
13. Michelson interferometer: Determination of wavelength of monochromatic light.
14. Determination of wavelength of laser light by diffraction single slit method.
15. Determination of wavelength of laser light by Interference Young's Double slit method.

Books Recommended.

1 Physics for Degree Students B. Sc. Second Year, by C. L. Arora and P. S. Hemne S. Chand &Co.
2 Electronics Instrumentation by H. S. Kalasi.
3 B.Sc. Practical Physics – C.L. Arora.
4 Advanced Practical Physics – Samir Kumar Ghosh.
5 Advanced Practical Physics – Worshnop and Flint.

Pedagogy: Problem solving, seminar, presentation, activities, group discussion, field visit etc.,

B. Sc. Semester – III

OEC- 3: Sports Science (Code: 003PHY051)

Total Hrs: 42

Unit-I: Measurements, Newton's Laws and Projectile Motion

Measurement: Physical quantities. Standards and Units. International system of Units. Standards of time, length and mass. Precision and significant figures.

Newton's laws of motion: Newton's first law. Force, mass. Newton's second law. Newton's third law. Mass and weight. Applications of Newton's laws.

Projectile motion: Shooting a falling target, Physics behind Shooting, Javelin throw and Discus throw.

Topics for self - Study (if any):

https://www.real-world-physics-problems.com/physics-of-sports.html **14 hrs**

Unit-II: Conservation Laws and Gravitation

Conservation Laws: Conservation of linear momentum, collisions – elastic and inelastic. Angular momentum. (Physics behind Carom, Billiards, Racing).

Centre of mass: Physics behind Cycling, rock climbing, Skating,

Gravitation: Origin, Newton's law of gravitation. Archimedes principle, Buoyancy (Physics behind swimming)

Topics for self-study (if any) Archimedes' Principle: Made EASY | Physics in You tube

Unit-III: Food and Nutrition, Energy and Physics Exercises **14 hrs**

Food and Nutrition: Proteins, Vitamins, Fat, Blood pressure. Problems due to the deficiency of vitamins.

Energy: Different forms of Energy, Conservation of mass-energy.

Physical exercises: Walking, Jogging and Running, Weight management.

Topics for self - Study (if any): 10 Best Exercises for Everyone – Healthline **14 hrs**

Books Recommended:

Sl No	Title of the Book	Authors Name
1	Physics for Entertainment	Yakov Perelman
2	Physics Everywhere	Yakov Perelman
3	Mechanics for Entertainment	Yakov Perelman
4	Hand book for food and Nutrition	M Swaminathan
5	Food Science	B. Srilakshmi
6	Physics	Resnick, Halliday and Krane, Vol 1
7	For the love of Physics	Walter Lewin
8	An Introduction to the Physics of Sports	VassiliosMcInnesS pathopoulos

B.Sc. Semester – IV

DSCC-7: Physics (Theory): VII (Code: 034PHY011)

Title of the Course (Theory): Thermal Physics and Electronics

Total Hrs: 56

Unit-I: Thermodynamics-I

Second Law of Thermodynamics: Review of basics of thermodynamics. Statements of second law of thermodynamics, Carnot theorem: statement and proof. Steam engine, Otto engine (Internal combustion engine) and expression for efficiency. Diesel engine and expression for efficiency.

Entropy: Concept of entropy, change in entropy, physical concept of entropy, change of entropy in reversible cycle, principle of increase of entropy, change of entropy in irreversible process with examples. Temperature- entropy diagram, physical significance of entropy, entropy of a perfect gas. Second law of thermodynamics in terms of entropy. Entropy of the Universe. Third law of thermodynamics: Nernst's heat theorem statement.

Suggested Activities: please refer foot note **14 hrs**

Unit-II: Thermodynamics-II

Maxwell's Thermodynamic Relations: Thermodynamic variables, extensive and intensive variables. Derivation of Maxwell's thermodynamical relations (general relationship). Applications: specific heat equation for Van der Waals gas, Joule-Thomson-cooling and Joule-Thomson coefficient for perfect and Van der Waal gas. Clausius - Clapeyron's equation (first latent heat equation).

Thermodynamic Potentials: Internal energy, Enthalpy, Helmholtz freeenergy, Gibbs free energy. Significance of thermodynamic potentials. Relations of thermodynamical potentials with their variables. First and second order phase transitions.

Suggested Activities: please refer foot note **14 hrs**

Unit-III: Electronics - I

Current and voltage sources and Network Theorems: Concept of voltage source: ideal and practical voltage source. Concept of current source: ideal and practical current source. Thevenin's and Norton's Theorems: statement and proof.

Power supply: Power supply with filters (LC and π- section), IC regulated power supply (78XX).

Bipolar Junction Transistor: BJT characteristics in CE mode, Operating point. Biasing of BJT: Mention different types of biasing, analysis of voltage divider biasing, derivation of IC and VCE. DC *h*-parameters and their determination using low frequency transistor model. Single stage RC coupled CE amplifier, Expression for current gain and voltage gain, input impedance and output impedance, frequency response. Brief explanation of positive and negative feedback. Transistor as an oscillator: Hartley, Colpitts and Phase shift oscillators (qualitative only).

Junction Field Effect Transistor: Types, characteristics and parameters of JFET.

Suggested Activities: please refer foot note **14 hrs**

Unit-IV: Electronics - II

Integrated Circuits (ICs): Introduction of ICs, Types of ICs, IC555 internal configuration, IC555 timer as astable multivibrator.

Operational Amplifier (Op-Amp): Ideal Op-Amp and its characteristics, practical Op-Amp, concept of virtual ground, Op-Amp parameters, Op-Amp with negative feedback, Inverting Op-amp: close loop voltage gain expression, input and output impedance. Non-inverting Op-Amp: close loop voltage gain expression. Op-Amp as adder, subtractor, voltage follower, integrator and differentiator.

Digital Electronics: Positive and negative logic levels, logic operations, NOT, OR, AND operations, construction of truth table. Digital logic gates: NOT, OR, AND, NOR, NAND, XOR, XNOR gates. Input-output timing diagram for NAND and NOR gates. Boolean theorems, De Morgan's theorems using truth table, using gates. Design of basic gates using NAND and NOR. Simplification of Boolean expressions.

Suggested Activities: please refer foot note **14 hrs**

Books Recommended.

1. Heat & Thermodynamics and Statistical Physics by Brijlal Subramanyam & Hemne - S Chand., Delhi
2. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
3. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
4. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1958, Indian Press
5. Heat and Thermodynamics (I-Edition) – D.S. Mathur - S. Chand & Company Ltd., New-Delhi, 1991.
6. A text book of heat - J. B. Rajam S. Chand and Co.
7. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springe
8. An Introduction to Thermal Physics, Daniel V Schroeder, 2020, Oxford University Press
9. Electronic Devices and Circuits by David A. Bell PHI, New Delhi 2004.
10. Integrated Electronics by Jacob Millman and CC Halkias.
11. Digital Fundamentals by Floyd PHI, New Delhi 2001.
12. Principle of Electronics by V. K. Mehta and Rakshit.
13. Basic electronics and solid state physics- B. L. Theraja- S. Chand Publication, New Delhi
14. Basic Electronics- B. L. Theraja- S. Chand Publication,New Delhi.
15. Integrated Electronics- Millmans And Halkias-McGraw Hill, New Delhi.
16. Electronic devices and circuits- Allan Mottersed-.McGraw Hill, New Delhi.
17. Basic Electronics and Linear Circuits- TTTI- Bhargav & Others. McGraw Hill Education (1983)
18. A text book Thermodynamics by Y. V. C. Rao, Universities Press (Ind.) Hyderabad.
19. A text book of heat by G. R. Noakes, London Macmillan and Co. Ltd.
20. Berkely Physics, Vol. No. I – ABC Publications, Bangalore & New-Delhi.
21. University Physics (XI-Edition)- Young & Freedman – Pearson Education, 2004

Pedagogy: Problem solving, seminar, presentation, activities, group discussion, field visit etc.,

B.Sc. Semester – IV

DSCC-8: Physics (Practical) - VIII Code : 034PHY012

Title of the Course (Practical): Thermal Physics and Electronics

List of the Experiments for 52 hrs / Semesters

1. Thermal conductivity of a bad conductor by Lee's and Charlton's method.
2. Thermal conductivity of copper by Searle's apparatus / Angstrom's method.
3. Verification of Clausius – Clapeyron equation and determination of specific enthalpy.
4. Mechanical equivalent of heat Callender and Barnes method.
5. To find the ratio of specific heats at constant pressure and constant volume for air using Clement
and Desorme's apparatus.
6. Specific Heat by cooling.
7. Norton's and Thevenin's theorem using unbalanced Wheatstone network.
8. Power supply using π- section filter and study of IC regulator 78XX
9. Astable multivibrator using IC 555
10. Hybrid parameters of BJT in CE mode
11. Single stage RC coupled CE amplifier
12. JFET characteristics
13. Hartley /Colpitt's oscillator using BJT / Phase shift Oscillator using OP-Amp
14. Op-Amp as Inverting and non-inverting amplifier
15. Basic gates using IC-7400./ Verification of D' Morgan's theorem and Boolean expressions.

Books Recommended:

1. Physics for Degree Students B. Sc. Second Year, by C. L. Arora & P. S. Hemne S. Chand &Co.
2. Electronics Instrumentation by H. S. Kalasi.
3. B.Sc. practical Physics – C.L. Arora.
4. Advanced practical Physics – Samir Kumar Ghosh.
5. Advanced practical Physics – Worshnop and Flint.

B.Sc. Semester – IV

OEC- 4: Medical Physics (Code: 004PHY051)

Total Hrs:42

Unit-I: Human Anatomy and Physiology

Overview of human anatomy - cells, cell structure, type of cells and their functions, tissues, organs, and their functions. Different systems in the human body, their structure and function, physiological properties of the circulatory system, digestive system, respiratory system endocrine system and nervous system. **14 hrs**

Unit-II: Physics of Medical Diagnostics

Principle of production of X-rays. Use of X-rays in medical diagnosis, X-ray imaging systems. Computed Tomography (CT): principle and generation of CT. Magnetic Resonance Imaging (MRI): basic principle and image characteristics. Ultrasound Imaging: production of ultrasound, transducers, Interaction of sound waves with body tissues, , acoustic coupling, image formation, modes of image display and color Doppler. **14 hrs**

Unit-III: Radiation Physics

Radiation units, exposure, absorbed dose, units: Rad, gray. Relative biological electiveness, effective dose, inverse square law. Interaction of radiation with matter: Compton and Photoelectric effect, Rem and Sievert, linear attenuation coefficient. Radiation detectors: Thimble Chamber, Condenser Chambers, Geiger Muller counter, Scintillation counters and solid state detectors, ionization chamber, Dosimeters, survey methods, area monitors, TLD, Semiconductor detectors. **14 hrs**

Class Room Activities

Unit I: Students can demonstrate the shape, size, positions and functions of different organs in the body with the help of models.

Unit II: The use of X-rays in the diagnosis of the fractured bone can be demonstrated with the help of a gamma source and a gamma ray survey meter. As the density of materials between the source and the detector changes the reading on the meter (or intensity of the beefing sound) changes.

Unit III: (i) Students can be asked to list out different type of cancers and possible causative factors. They can be asked to list out the healthy practices to reduce the risk of cancers.

(ii) As there will be students from different disciplines in the OE course, group discussion can be arranged to discuss about their programme and outcome. This will be an opportunity for the students to know about other disciplines.

Other related activities/projects:

1. Visit to nearby hospitals/diagnostic centers to study the working of X-ray machines.
2. Visit to ultrasound diagnostic centers to study the principle and use of ultrasound in diagnosis.
3. Project on principle and use of X-ray films in imaging.
4. Visit to radiotherapy centers to study the modalities of radiotherapy.

Text Books

1. C. H. Best and N. B. Taylor. A Test in Applied Physiology. Williams and Wilkins Company, Baltimore, 1999.
2. C. K. Warrick. Anatomy and Physiology for Radiographers. Oxford University Press, 2001.
3. Jerrold T. Bushberg. The Essential Physics for Medical Imaging (2nd Edition). Lippincott Williams & Wilkins, 2002.
4. Jean A. Pope. Medical Physics: Imaging. Heinemann Publishers, 2012.
5. Faiz M. Khan and Roger A. Potish. Treatment Planning in Radiation Oncology. Williams and Wilkins, USA, 2003.
6. D. Baltas. The physics of modern brachytherapy for oncology. Taylor and Francis, 2007.

Reference Books

1. J. R. Brobek. Physiological Basis of Medical Practice. Williams and Wilkins, London, 1995.
2. Edward Alcamo, Barbara Krumhardt. Barron's Anatomy and Physiology the Easy Way. Barron's Educational Series, 2004.
3. Lippincott, Anatomy and Physiology. Lippincott Williams & Wilkins, 2002.
4. W. E. Arnould Taylor. A textbook of anatomy and physiology, Nelson Thornes, 1998.
5. G. S. Pant. Advances in Diagnositc Medical Physics. Himalaya Publishing House, 2006.
6. Sabbahaga, Diagnositc Ultrasound applied to OBG. Maryland, 1980.
7. Faiz M Khan. The Physics of Radiation Therapy (3rd edition). Lippincott Williams & Wilkins, USA, 2003.
8. Jatinder R. Palta and T. Rockwell Mackie. Intensity Modulation Radiation Therapy. Medical Physics publishing, Madison, Wisconsin, 2003.
9. AAPM Report No. 72. Basic Applications of Multileaf collimators, AAPM, USA, 2001.
10. AAPM Report No. 91. Management of Respiratory motion in radiation oncology, 2006.
11. CA Joslin, A. Flynn, E. J. hall. Principles and Practice of Brachytherapy. Arnold publications, 2001.
12. Peter Hoskin, Catherine Coyle. Radiotherapy in Practice. Oxford University Press, 2011.
13. W. R. Handee. Medical Radiation Physics. Year Book Medical Publishers Inc., London, 2003.
14. Donald T. Graham, Paul J. Coke. Principles of Radiological Physics. Churchill Livingstone, 2003.
15. Thomas S. Curry. Christensen’s Physics of Diagnostic Radiology (4th Edition). Lippincott Williams & Wilkins, 1990.
16. Madison. MRI – Perry Sprawls – Medical Physics Publishing. Wisconsin, 2000.