Engineering physics syllabus

Engineering physics examinations

Group A - Compulsory examinations (seven required)

17-Phys-A1 Classical Mechanics

Review of fundamental principles; Lagrangian Mechanics; non-conservative and non-holomonic systems; central force problem; motion of a rigid body; variational principles, and an introduction to Hamilton's equations.

Textbooks (most recent edition is recommended):

Primary Text:

- Goldstein, Herbert, Charles P. Poole and John L. Safko, Classical Mechanics, 3rd Edition. Addison Wesley, 2001.

Secondary Text:

- Hibbeler, R.C., Engineering Mechanics: Dynamics, 8th edition, Prentice-Hall, Englewood Cliffs, N.J., 1998.
- Taylor, John R., Classical Mechanics, University Science Books, 2004.

17-Phys-A2 Statistical Physics

Kinetic theory of gases; Quantum states, temperature, entropy, chemical potential, Boltzmann factor, fermions and bosons. Fermi-Dirac distributions and electrons in metals. Bose-Einstein distributions and photons, Black-body radiation, Debye theory of phonons.

Textbooks (most recent edition is recommended):

Primary Text:

- Charles Kittel and Herbert Kroemer, Thermal Physics, W H Freeman & Co (Sd); 2nd ed. edition (Dec 17 2012)

Secondary Text:

- Reif, F., Fundamentals of Statistical and Thermal Physics, McGraw-Hill Inc., 1965.

17-Phys-A3 Electromagnetics (16-Elec-A7)

Field concepts. Maxwell's equations. Free space and guided wave propagation, transmission lines. Characteristic impedance. Impedance matching and transformation. Fields of moving charges, electromagnetic induction, radiation, and antennae.

Textbooks (most recent edition is recommended):

- Demarest, Engineering Electromagnetics, Prentice-Hall.
- Hayt, William H. and John A. Buck, Engineering Electromagnetics, McGraw Hill, 2006. ISBN: 0073104639.

17-Phys-A4 Quantum Mechanics

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Breakdown of classical mechanics. Schrodinger equation and elementary systems; one dimensional problems. Postulates and interpretation of quantum mechanics. Algebraic solution of the Schrodinger equation for the harmonic oscillator. Angular momentum and spin. Central force problems; the hydrogenic atom. Concepts and applications of tunneling. Perturbation theory.

Textbooks (most recent edition is recommended):

- Basdevant, J.-L., & J. Dalibard, Mécanique quantique, Éditions de l'École Polytechnique, Paris, 2002.
- Griffiths, D.J., Introduction to Quantum Mechanics, 2nd Edition. Pearson-Prentice Hall, New Jersey, 2005.

17-Phys-A5-A Electronic Materials and Devices

Semiconductor physics; band theory, drift and diffusion. Semiconductor devices; diodes, bipolar and MOS devices, sensors and transducers. Other electronics related materials; dielectrics, piezoelectrics, and magnetic materials and their application to modern sensors and transducers.

Textbooks (most recent edition is recommended):

Primary Text:

- Streetman, B.G., Solid State Electronic Devices, 4th edition. Prentice-Hall, Englewood Cliffs, N.J, 1995.

Secondary Text:

- Sedra, Adel and Kenneth C. Smith., Microelectronic Circuits, 5th Edition. Oxford Press. 2007.

17-Phys-A5-B Analog and Digital Electronic Circuits

Time and frequency domain analysis of linear and nonlinear circuits. Biasing and small signal analysis of transistor amplifiers. Operational amplifiers. Feedback and stability of amplifiers. Oscillators and active filters. Digital circuits and logic families; D/A and A/D conversion; instrumentation.

Textbooks (most recent edition is recommended):

- Sedra, Adel and Kenneth C. Smith., Microelectronic Circuits, 5th Edition. Oxford Press. 2007.

17-Phys-A6 Solid State Physics

Lattice structure and bonding. Lattice vibrations and phonons. Electrons in solids, band structure of metals, semiconductors and insulators, the Fermi surface. The effects of reduced size/dimensionality, i.e., nanostructures. Semiconductors and junctions. Paramagnetism and diamagnetism. Introduction to lattice defects.

Textbooks (most recent edition is recommended):

Primary Text:

- Kittel, C., Introduction to Solid State Physics, 6th edition. John Wiley and Sons, 1986.

Secondary Text:

- Ashcroft, N.W and Mermin, N.D., Solid State Physics, Saunders College, 1976.

17-Phys-A7 Optics

Gaussian optics, optical instruments, matrix analysis of lens systems, aberrations, polarization: Double and multiple-beam interference. Fraunhofer and Fresnel diffraction, optical waveguides, fibre optics, contemporary optics design.

Textbooks (most recent edition is recommended):

- Hecht E. and Zajac, A., Optics, 2nd edition. Addison-Wesley, 1987.

Group B - Optional examinations (three required)

17-Phys-B1 Radiation Physics

Atomic and nuclear structure, isotopes, radioactivity, X-rays, attenuation and absorption in matter, detection of radiation, radiation instrumentation, dosimetry, radiation protection, radiation safety and standards, non-ionizing radiation.

Textbooks (most recent edition is recommended):

- Camber, H., Introduction to Health Physics, 3rd edition. McGraw-Hill, NY, 1996.

17-Phys-B2 Electro-Optical Engineering (16-Elec-B10)

Optical transmission: waveguide modes, fiber optics, fibre optic propagation characteristics. Optoelectronics: optical resonators, lasers, sources and detectors, couplers, modulators, guided wave devices. Applications.

Textbooks (most recent edition is recommended):

- Yariv, Amnon, and Pochi Yeh, Photonics: Optical Electronics in Modern Communication, 6th Edition. Oxford University Press, 2006.

17-Phys-B3 Digital Systems and Computers (16-Elec-A4)

Combinatorial and sequential switching circuits. Register level design of digital systems. Computer memories. Computer architecture, assembly language programming, interrupts, and interfacing.

Textbooks (most recent edition is recommended):

- Brey, Barry, The Motorola Microprocessor Family: 68000, 68008, 68010, 68020, 68030, and 68040: Programming and Interfacing with Applications. Saunders College Publishing, 1995.

17-Phys-B4 Signals and Communications (16-Elec-A3)

Amplitude and frequency modulation systems: signals, spectra, implementation. Sampling of continuous signals and the Nyquist sampling theorem. Fourier series and transforms, spectral concepts. Discrete signals and systems: the sampling theorem, time and frequency response, the Z-transform. PCM and simple baseband pulse code modulation systems. Digital modulation techniques, e.g., ASK, PSK, QAM.

Textbooks (most recent edition is recommended):

- Haykin, Simon & Barry Van Veen, Signals and Systems, 2005 Interactive Solutions, Edition, 2nd Edition, John Wiley & Sons Canada Ltd., 2005.
- Haykin, Communication Systems, 4th Edition, John Wiley & Sons Canada Ltd., 2000.

Or

- Haykin, Simon & Michael Moher, Introduction to Analog and Digital Communication Systems, 2nd Edition, John Wiley & Sons, 2006.

17-Phys-B5 Systems and Control (16-Elec-A2)

Models, transfer functions, and system response. Root locus analysis and design. Feedback and stability:

Bodes diagrams. Nyquist criterion, frequency domain design. State variable representation. Simple PID control systems.

Textbooks (most recent edition is recommended):

- Dorf, Richard C. and Robert H. Bishop, Modern Control Systems, 10th Edition. Addison-Wesley, 2004.
- Nise, Norman S., Control Systems Engineering, 4th Edition, Wiley, 2003

17-Phys-B6 Applied Thermodynamics and Heat Transfer (16-Mec-A1)

Applied Thermodynamics: Review of fundamental laws and their applications to closed and open systems. Vapour cycles for power and refrigeration; cycle modifications including reheat, regeneration. Gas cycles; spark ignition and compression ignition cycles. Gas turbine cycles, including modifications such as regeneration and intercooling; effects of component efficiency on performance. Heat Transfer: Conduction in one and two-dimensional systems; steady state and transient regimes. Natural – and forced-convection problems. Radiation heat exchange between black, gray, and real surfaces. Thermal design of heat exchangers.

Textbooks (most recent edition is recommended):

- Moran, M.J., H.N Shapiro, B.R. Munson and D.P. DeWitt, Introduction to Thermal Systems Engineering: Thermodynamics, Fluid Mechanics, and Heat Transfer. John Wiley and Sons. 2002.

17-Phys-B7 Structure of Materials (10-Met-A4)

Atomic and molecular structure. Metallic, ionic, covalent and Van der Walls's, Crystal structure, space lattices and Miller indices. Crystalline and non-crystalline (amorphous). Solidification (crystallisation) and associated microstructures of cast metals and phenomena of grain boundaries. Observations of material structure (X-ray techniques, metallography, optical and electron microscopy). Defects in solids, dislocation and slip, vacancies and diffusion. Basic mechanisms of deformation processes of materials. Phase diagrams (solid solution systems, eutectic and eutectoid systems, peritectic reaction, intermetallic compounds). Application of lever rule to phase proportions in common single - and binary-phase systems.

Textbooks (most recent edition is recommended):

Primary Text:

- Reed-Hill, R.E. and R. Abbaschian, Physical Metallurgy Principles. (3rd edition) PWS Kent Publishers, Boston, 1992. ISBN 0534921736.

Secondary Text:

- Cullity, BD and Stock, SR., Elements of X-ray Diffraction, 3rd Edition. Prentice Hall, Upper Saddle River NJ, 2001 ISBN 0-201-61091-4 Chaps 1-3.