SYLLABUS FOR WRITTEN EXAMINATION

1. Syllabus Electronics and Communications (STCM, STBM, STBE)

General Aptitude (GA)	15 marks.
Engineering Mathematics	15 marks.
Core subject Questions	70 marks.

General Aptitude

Verbal Ability: English grammar, sentence completion, verbal analogies, word groups, instructions, critical reasoning and verbal deduction.

Numerical Ability: Numerical computation, numerical estimation, numerical reasoning and data interpretation.

Engineering Mathematics

Linear Algebra: Vector space, basis, linear dependence and independence, matrix algebra, eigenvalues and eigen vectors, rank, solution of linear equations – existence and uniqueness.
Calculus: Mean value theorems, theorems of integral calculus, evaluation of definite and improper integrals, partial derivatives, maxima and minima, multiple integrals, line, surface and volume integrals, Taylor series.
Differential Equations: First order equations (linear and nonlinear), higher order linear differential equations, Cauchy's and Euler's equations, methods of solution using variation of parameters, complementary function and particular integral, partial differential equations, variable separable method, initial and boundary value problems.
Vector Analysis: Vectors in plane and space, vector operations, gradient, divergence and curl, Gauss's, Green's and Stoke's theorems.
Complex Analysis: Analytic functions, Cauchy's integral theorem, Cauchy's integral formula; Taylor's and Laurent's series, residue theorem.
Numerical Methods: Solution of nonlinear equations, single and multi- step methods for differential equations, convergence criteria.
Probability and Statistics: Mean, median, mode and standard deviation; combinatorial probability, probability distribution functions - binomial, Poisson, exponential and normal; Joint and conditional probability; Correlation and regression analysis.

Electronics & Communications Engineering (70 marks)

Networks, Signals and Systems

Network solution methods: nodal and mesh analysis; Network theorems: superposition, Thevenin and Norton’s, maximum power transfer; Wye-Delta transformation; Steady state sinusoidal analysis using phasors; Time domain analysis of simple linear circuits; Solution of network equations using Laplace transform; Frequency domain analysis of RLC circuits;

Linear 2-port network parameters: driving point and transfer functions; State equations for networks.
Continuous-time signals: Fourier series and Fourier transform representations, sampling theorem and applications;
Discrete-time signals: discrete-time Fourier transform (DTFT), DFT, FFT,
Z-transform, interpolation of discrete-time signals;
LTI systems: definition and properties, causality, stability, impulse response, convolution, poles and zeros, parallel and cascade structure, frequency response, group delay, phase delay, digital filter design techniques.

Electronic Devices

Energy bands in intrinsic and extrinsic silicon; Carrier transport: diffusion current, drift current, mobility and resistivity; Generation and recombination of carriers; Poisson and continuity equations; P-N junction, Zener diode, BJT, MOS capacitor, MOSFET, LED, photo diode and solar cell; Integrated circuit fabrication process;

Analog Circuits

Small signal equivalent circuits of diodes, BJTs and MOSFETs; Simple diode circuits: clipping, clamping and rectifiers; BJT and MOSFET amplifiers: Single-stage biasing, bias stability, mid-frequency small signal analysis and frequency response; multi-stage, differential, feedback, power and operational; Simple op-amp circuits; Active filters;
Sinusoidal oscillators: criterion for oscillation, single-transistor and op- amp configurations; Function generators, wave-shaping circuits and 555 timers; Voltage reference circuits;
Power supplies: ripple removal and regulation.

Digital Circuits

Number systems;
Combination circuits: Boolean algebra, minimization of functions using Boolean identities and Karnaugh map, logic gates and their static CMOS implementations, arithmetic circuits, code converters, multiplexers, decoders and PLAs;

Sequential circuits: latches, flip-flops, counters, shift-registers and finite state machines;

Data converters: sample and hold circuits, ADCs and DACs
Semiconductor memories: ROM, SRAM, DRAM;
8-bit microprocessor (8085): architecture, programming, memory and I/O interfacing.

Control Systems

Basic control system components; Feedback principle; Transfer function; Block diagram representation; Signal flow graph; Transient and steady-state analysis of LTI systems; Frequency response; Routh-Hurwitz and Nyquist stability criteria; Bode and root-locus plots; Lag, lead and lag-lead compensation; State variable model and solution of state equation of LTI systems.

Communications

Random processes: autocorrelation and power spectral density, properties of white noise, filtering of random signals through LTI systems;
Analog communications: amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, superheterodyne receivers, circuits for analog

communications;
Information theory: entropy, mutual information and channel capacity theorem; Digital communications: PCM, DPCM, digital modulation schemes, amplitude, phase and frequency shift keying (ASK, PSK, FSK), QAM, MAP and ML decoding, matched filter receiver, calculation of bandwidth, SNR and BER for digital modulation; Fundamentals of error correction, Hamming codes; Timing and frequency synchronization, inter-symbol interference and its mitigation; Basics of TDMA, FDMA and CDMA.

Electromagnetics
Electrostatics; Maxwell's equations: differential and integral forms and their interpretation, boundary conditions, wave equation, Poynting vector;
Plane waves and properties: reflection and refraction, polarization, phase and group velocity, propagation through various media, skin depth;
Transmission lines: equations, characteristic impedance, impedance matching, impedance transformation, S-parameters, Smith chart;
Waveguides: modes, boundary conditions, cut-off frequencies, dispersion relations; Antennas: antenna types, radiation pattern, gain and directivity, return loss, antenna arrays; Basics of radar; Light propagation in optical fibers.

2. Syllabus: STBP PHYSICS

General Aptitude:	15 marks
Core subject	85 marks

GA: General Aptitude

Verbal Ability: English grammar, sentence completion, verbal analogies, word groups, instructions, critical reasoning and verbal deduction.
Numerical Ability: Numerical computation, numerical estimation, numerical reasoning and data interpretation.

Subject Paper Physics

Mathematical Physics

Linear vector space: basis, orthogonality and completeness; matrices; vector calculus; linear differential equations; elements of complex analysis: Cauchy- Riemann conditions, Cauchy's theorems, singularities, residue theorem and applications; Laplace transforms, Fourier analysis; elementary ideas about tensors: covariant and contravariant tensor, Levi-Civita and Christoffel symbols.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential

equations.

Interpolation: Linear interpolation, Lagrange Interpolation, Newton Interpolation, Divided Difference, Curve Fitting.

Classical Mechanics

D'Alembert's principle, cyclic coordinates, variational principle, Lagrange's equation of motion, central force and scattering problems, rigid body motion; small oscillations, Hamilton's formalisms; Poisson bracket; special theory of relativity: Lorentz transformations, relativistic kinematics, mass- energy equivalence.

Electromagnetic Theory

Solutions of electrostatic and magnetostatic problems including boundary value problems; dielectrics and conductors; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; Electromagnetic waves and their reflection, refraction, interference, diffraction and polarization; Poynting vector, Poynting theorem, energy and momentum of electromagnetic waves; radiation from a moving charge.

Quantum Mechanics

Postulates of quantum mechanics; uncertainty principle; Schrodinger equation; one-, two- and three- dimensional potential problems; particle in a box, transmission through one dimensional potential barriers, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momenta; time independent perturbation theory; elementary scatteringtheory.

Thermodynamics and Statistical Physics

Laws of thermodynamics; macrostates and microstates; phase space; ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, phase equilibria, critical point.

Atomic and Molecular Physics

Spectra of one- and many- electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck- Condon principle; Raman effect; NMR, ESR, X-ray spectra; lasers: Einstein coefficients, population inversion, two and three level systems.

Solid State Physics & Electronics

Elements of crystallography; diffraction methods for structure determination; bonding in solids; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids: nearly free electron and tight binding models; metals, semiconductors and insulators; conductivity, mobility and effective mass; optical, dielectric and magnetic properties of solids; elements of superconductivity: Type-I and Type II superconductors, Meissner effect, London equation.

Semiconductor devices: diodes, Bipolar Junction Transistors, Field Effect Transistors; operational amplifiers: negative feedback circuits, active filters and oscillators; regulated

power supplies; basic digital logic circuits, sequential circuits, flip- flops, counters, registers, A/D and D/A conversion.

Nuclear and Particle Physics

Nuclear radii and charge distributions, nuclear binding energy, Electric and magnetic moments; nuclear models, liquid drop model: semi- empirical mass formula, Fermi gas model of nucleus, nuclear shell model; nuclear force and two nucleon problem; alpha decay, beta-decay, electromagnetic transitions in nuclei; Rutherford scattering, nuclear reactions, conservation laws; fission and fusion; particle accelerators and detectors; elementary particles, photons, baryons, mesons and leptons; quark model.

General properties of alpha, beta and gamma rays, Laws of radioactivity, Van De Graff Generator, Pelletron, Cyclotron, Betatron, Synchro-Cyclotron, Linear Accelerator, Klystron and magnetron, Travelling and Standing Wave Acceleration, Microtron, Electron Synchrotron, Proton synchrotron.
Interaction of electromagnetic radiation with matter, Interaction of charged particles with matter, Cerenkov radiation, Electron absorption process, Scattering, Excitation and Ionization, Radiative collision, Bremmstrahlung, Shielding

Vacuum and Vacuum devices, Pumping techniques, Leak detection.

3. Syllabus: STBR Radiological Physics

General Aptitude:	15 marks
Core subject	85 marks

GA: General Aptitude

Verbal Ability: English grammar, sentence completion, verbal analogies, word groups, instructions, critical reasoning and verbal deduction.

Numerical Ability: Numerical computation, numerical estimation, numerical reasoning and data interpretation.

Subject Paper

Mathematical Physics

Linear vector space: basis, orthogonality and completeness; matrices; vector calculus; linear differential equations; elements of complex analysis: Cauchy- Riemann conditions, Cauchy's theorems, singularities, residue theorem and applications; Laplace transforms, Fourier analysis; elementary ideas about tensors: covariant and contravariant tensor, Levi-Civita and Christoffel symbols.
Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.
Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential

equations.
Interpolation: Linear interpolation – Lagrange Interpolation - Newton Interpolation – Divided Difference. Curve Fitting.

Classical Mechanics

D'Alembert's principle, cyclic coordinates, variational principle, Lagrange's equation of motion, central force and scattering problems, rigid body motion; small oscillations, Hamilton's formalisms; Poisson bracket; special theory of relativity: Lorentz transformations, relativistic kinematics, mass- energy equivalence.

Electromagnetic Theory

Solutions of electrostatic and magnetostatic problems including boundary value problems; dielectrics and conductors; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; Electromagnetic waves and their reflection, refraction, interference, diffraction and polarization; Poynting vector, Poynting theorem, energy and momentum of electromagnetic waves; radiation from a moving charge.

Quantum Mechanics

Postulates of quantum mechanics; uncertainty principle; Schrodinger equation; one-, two- and three- dimensional potential problems; particle in a box, transmission through one dimensional potential barriers, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momenta; time independent perturbation theory; elementary scatteringtheory.

Thermodynamics and Statistical Physics

Laws of thermodynamics; macro-states and microstates; phase space; ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, phase equilibria, critical point.

Atomic and Molecular Physics

Spectra of one- and many- electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck- Condon principle; Raman effect; NMR, ESR, X-ray spectra; lasers: Einstein coefficients, population inversion, two and three level systems.

Dosimetry & Standardization of X- and Gamma Ray Beams

Radiation Quantities and Units, Radiation Sources, Dosimetry & Standardization of X- and Gamma Ray Beams, Neutron Standards & Dosimetry, Standardization of Radionuclides, Radiation Chemistry and Chemical Dosimetry

Radiation Detection, Measurement and Nuclear Electronics:

Principles of radiation detection and general properties of detectors: Principles of radiation detection, modes of detector operation, Pulse height spectra, Counting curves and plateaus, Energy resolution, Detector efficiency, Dead time, detector window.

Gas filled radiation detectors, Scintillation (organic/inorganic) and semiconductor detectors, Neutron detectors, New type of detectors, Basic building blocks used in nuclear measurement

Dosimeters based on condenser chamber, quartz fibre electrometer, dosimeter based on current measurement, secondary standard dosimeter, Farmer dosimeter, beam therapy dosimeter, clinical dosimeter, isotope calibrator, Radiation field analyzer (RFA)
Instruments for personal monitoring: TLD Reader for medical & research applications, TLD Badge Reader, OSLD badge reader, Film Badge Reader, Densitometer, Digital pocket dosimeter.

Area monitoring instruments: Portable and fixed area monitors, fixed area monitors, beta-gamma zone

monitor, Survey meters, wide range survey instrument, portable contamination monitor, hand &foot surface contamination monitor, portal monitor, laundry monitor, floor monitor, Neutron monitoring instruments, REM counter, Whole body counter. Calibration of Radiation Protection Instruments

Nuclear and Particle Physics

Nuclear radii and charge distributions, nuclear binding energy, Electric and magnetic moments; nuclear models, liquid drop model: semi- empirical mass formula, Fermi gas model of nucleus, nuclear shell model; nuclear force and two nucleon problem; alpha decay, beta-decay, electromagnetic transitions in nuclei; Rutherford scattering, nuclear reactions, conservation laws; fission and fusion; particle accelerators and detectors; elementary particles, photons, baryons, mesons and leptons; quark model.

Radioactivity: General properties of alpha, beta and gamma rays, Laws of radioactivity,Laws of successive transformations, Natural radioactive series, Radioactive equilibrium, Theory of beta decay, Gamma emission, Electron capture, Internal conversion, Nuclear isomerism, Artificial radioactivity, Nuclear cross sections, Elementary ideas of fission and reactors, Fusion.

Particle accelerators for industrial, medical and research applications: Cascade generator, Van De Graff Generator, Pelletron, Cyclotron, Betatron, Synchro-Cyclotron, Linear Accelerator, Klystron and magnetron, Travelling and Standing Wave Acceleration, Microtron, Electron Synchrotron, Proton synchrotron.

Interaction of electromagnetic radiation with matter Exponential attenuation, Thomson scattering, Photoelectric and Compton process and energy absorption, Pair production, Attenuation and mass energy absorption coefficients, Relative importance of various processes.

Interaction of charged particles with matter, Classical theory of inelastic collisions with atomic electrons, Energy loss per ion pair by primary and secondary ionization, Dependence of collision energy losses on the physical and chemical state of the absorber, Cerenkov radiation, Electron absorption process, Scattering, Excitation and Ionization, Radiative collision, Bremmstrahlung, Range energy relation, Continuous slowing down approximation (CSDA) , straight ahead approximation and detour factors , transmission and depth dependence methods for determination of particle penetration , empirical relations between range and energy, Back scattering.
Passage of heavy charged particles through matter, Energy loss by collision, Range energy

relation, Bragg curve , Specific ionization , Stopping Power , Bethe Bloch Formula. Interaction of neutrons with matter, scattering , capture , Neutron induced nuclear reactions.

4. Syllabus Atmospheric Science STBA

General Aptitude (GA)	15 marks.
Engineering Mathematics	15 marks.
Core subject (atmospheric science)	70 marks.

GENERAL APTITUDE

Verbal Ability: English grammar, sentence completion, verbal analogies, word groups, instructions, critical reasoning and verbal deduction.

Numerical Ability: Numerical computation, numerical estimation, numerical reasoning and data interpretation.

Engineering Mathematics

Linear Algebra: Vector space, basis, linear dependence and independence, matrix algebra, eigenvalues and eigen vectors, rank, solution of linear equations – existence and uniqueness.
Calculus: Mean value theorems, theorems of integral calculus, evaluation of definite and improper integrals, partial derivatives, maxima and minima, multiple integrals, line, surface and volume integrals, Taylor series.
Differential Equations: First order equations (linear and nonlinear), higher order linear differential equations, Cauchy's and Euler's equations, methods of solution using variation of parameters, complementary function and particular integral, partial differential equations, variable separable method, initial and boundary value problems.
Vector Analysis: Vectors in plane and space, vector operations, gradient, divergence and curl, Gauss's, Green's and Stoke's theorems.
Complex Analysis: Analytic functions, Cauchy's integral theorem, Cauchy's integral formula; Taylor's and Laurent's series, residue theorem.
Numerical Methods: Solution of nonlinear equations, single and multi- step methods for differential equations, convergence criteria.
Probability and Statistics: Mean, median, mode and standard deviation; combinatorial probability, probability distribution functions - binomial, Poisson, exponential and normal; Joint and conditional probability; Correlation and regression analysis.

Atmospheric Science

Fundamental of Meteorology, Thermal structure of the atmosphere and its composition, RadiationBalance and Laws, Wind Belts, Monsoon, Climate. Atmospheric Thermodynamics. Hydrostatic equilibrium and: Hydrostatic equation, variation of pressure with height, geopotential, Tropical convection. Atmospheric Electricity. Cloud Physics. Observation Techniques of the Atmosepheric Properties.

Fundamental equations. Pressure, gravity, centripetal and Corolis forces, continuity equation in Cartesian and isobaric coordinates, Scale analysis, inertial flow, geostrophic and gradient winds, thermal wind, vorticity. Atmospheric turbulence, baroclinic instabiltiy. Atmosphreric Waves.

Tropical meteorology: Trade wind inversion, ITCZ; monsoon trough tropical cyclones, their structure and development theory; monsoon depressions; Climate variability and forcings; Madden-Julian oscillation (MJO), ENSO, QBO (quasi-biennial oscillation) and sunspot cycles. Primitive equations of Numerical Weather Prediction. General Circulation and Climate Modelling.

Synoptic weather forecasting, prediction of weather elements such as rain, maximum and minimum temperature and fog. Data Assimilation.