Maharashtra State Eligibility Test for Lectureship
महाराष्ट्र राज्य व्यावसायिकपदाधिकारी राज्यस्तरीय पादरीता चाचणी (सेट) परीक्षा

Conducted by University of Pune
(AS THE STATE AGENCY)

SYLLABUS AND SAMPLE QUESTIONS

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UNIVERSITY OF PUNE
Ganeshkhind, Pune-411007
[32] : PHYSICAL SCIENCES

The syllabus consists of two papers, as follows:
Paper II and Paper III will be of 75 minutes and 2½ hours duration respectively. Paper II will be of 100 marks and Paper III will be of 200 marks.

PAPER II


Principles and conceptual basis of: (i) Optical sources, interferometry for wavelength measurements, (ii) Production and measurement of low pressure (vacuum), (iii) Power and single crystal (Laue) X-ray diffraction techniques, (iv) Measurements of signals, signal to noise ratio.

**PAPER III**

Part A Weightage 50%

SYLLABUS SAME AS FOR PAPER II

Part B Weightage 50%

1. **Electronics**


Applications of semiconductor devices in linear and digital circuits-Zener regulated power supply, Transistor (bipolar, MOSFFT, JFET) as amplifier, coupling of amplifier stages (DC, RC and Transformer coupling), RC-coupled amplifier, dc and power amplifier Feedback in amplifiers and oscillators (phase swift, Hartley, Colpitts and crustal controlled) clipping and clamping circuits. Transistor as a switch OR, AND and NOT gates (TIL and CMOS gates). Multivibrators (using transistor) and sweep geneator (using transistors, UJT and SCR).

Linear integrated circuits-Operational amplifier and its applications-Inverting and noninverting amplifier, adder, integrator, differentiator, waveform geneator, comparator and Schmittrigger, Butterwoth active filter, phase shifter, Digital integrated circuits-NAND and NOR gates building block, X-OR gate, simple combinational circuits-Half and full address, Flip-Flops, shift registers, counters, A/D and D/A coverters, semiconductor memories (ROM, RAM, and EPROM, basic, architecture of 8 bit microprocessor (INTEL 8085).

Communication Electronics-Basic principle of amplitude frequency and phase modulation. Simple circuits for amplitude modulation and demodulation, digital (PCM) modulation and demodulation. Fundamentals of optical communication, Microwave Oscillators (reflex, klystron, megneton and Gunn diode), Cavity resonaters. Standing wave detector.

2. **Atomic and Molecular Physics**


Exchange symmetry of wave functions, Pauli exclusion priciples, periodic table, alkali-type spectra, LS and JJ coupling, Hund’s rules and term reversal.
Machanisms of line broadening.

Zeeman, Paschen-Back and Stark effects.

Inner-shell vacancy, X-rays and Auger transitions, Compton effect.

Principles of resonance Spectroscopy (ESR and NMR)

Molecular Physics-Covalent, ionic and Van der Waal’s interaction, Born-Oppenheimer approximation.

Heitler-London and molecular orbital theories of $H_2$.

Rotation, rotation-vibration spectra, Raman Spectra, selection rules, nuclear spin and intensity alteration, isotope effects, electronics states of diatomic molecules, Franck-Condon principle.

Laser-spontaneous and stimulated emission, optical pumping, population inversion, coherence (temporal and spatial), simple description of ammonia maser, $CO_2$ and He-Ne lasers.

3. Condensed Matter Physics-Crystal classes and system, 2d and 3d lattices, bonding of common crystal structure; reciprocal lattice, diffraction and structure factor, elementary ideas about point defect and dislocations, short and long range order in liquids and solids, liquid crystals, quasicrystals and glasses.

Lattice vibrations, phonons, specific heat of solids. Free electron theory. Fermi statistics, heat capacity and Pauli paramagnetic susceptibility.

Electron motion in periodic potentials energy bands in metals, insulators and semiconductors, tight binding approximation, impurity levels in doped semiconductors.

Dielectrics-Polarization mechanisms, Clausius-Mossotti equation, piezo, pyro and ferroelectricity.

Dia and Para magnetism, exchange interactions, magnetic order, ferro, anti ferro and ferromagnetism.

Superconductivity-basic phenomenology, Meissner effect, Type I and Type II super conductors, BCS pairing mechanisms, High Tc materials.

4. Nuclear and Particle Physics

Basic nuclear properties-size, shape, charge distribution; spin and parity, binding, empirical mass formula, liquid drop model, nuclear stability and radioactive decay.


Interactions of charged particles and X-rays with matter, Basic principles of particle detectors-ionization chamber, proportional counter and GM counters, solid state detectors-scintillation and semiconductor detectors.

Radioactive decays- $[\alpha \beta \gamma]$ decays, their classifications and characteristics. Basic theoretical understanding.
Nuclear reactions—Q values and kinematics of nuclear cross-sections, its energy and angular dependence, elementary ideas of reaction mechanisms, elementary ideas of fission and fusion.

Particle Physics—Classification of fundamental forces and elementary particles, Isospin, strangeness, Gell-Mann-Nishijima formula.

Quark model + SU (3) symmetry.

C.T.P invariances in different interactions, weak interactions, parity-non conservation, K-meson complex and time reversal invariance, elementary ideas of geuge theory of strong and weak interactions.

SAMPLE QUESTIONS

PAPER II

1. The value of the continued fraction

\[
\frac{1}{1 + \frac{1}{1 + \frac{1}{1 + \frac{1}{1 + \cdots}}} }
\]

is equal to

(A) 0,
(B) 1,
(C) \( \sqrt{5} - 1)/2, \)
(D) \( \sqrt{5} /2, \)

Answer [C]

2. The period of satellite in a circular orbit of radius R is T. The period of another satellite in a circular orbit of 4R radius is

(A) at,
(B) T/4
(C) 8T
(D) T/8

Answer [C]
PAPER III

1. Show that if a particle describes a circular orbit under the influence of an attractive central force directed towards a point on the circle, then attractive force varies as $r^{-5}$.

2. A charged Harmonic oscillator is oscillating along $x$ axis. A uniform electric field $\vec{E} = E_o \hat{i}$ is applied along $x$ axis. Using second order perturbation theory find the correction to $n$th energy level.

Given : 
\[
\langle n + 1 | x | n \rangle = \frac{1}{\alpha} \sqrt{\frac{n}{2}}
\]
\[
\langle n | x | n + 1 \rangle = \frac{1}{\alpha} \sqrt{\frac{n + 1}{2}}
\]

Where $\alpha = (m w / \hbar)^{1/2}$. 
