B.Sc. Semester-V (Honours) Examination, 2021 (CBCS)
Subject: Physics
Paper: DSE-2 (Communication Systems)

Time: 2 Hours **Full Marks: 40**

The questions are of equal value. Candidates are required to give their answers in their own words as far as practicable.

Answer any ***eight*** of the following questions 5 x 8 = 40

1. What do you understand by the term baseband signal? List the drawbacks of baseband transmission. Why is modulation needed?
2. Draw the waveform of an amplitude modulated wave with sinusoidal modulation.
   From the display of an AM envelope on an oscilloscope, the measured values of V_{max} and V_{min} are 150 mV and 70 mV peak-to-peak respectively. Compute the value of amplitude modulation index, m_a and percent modulation. What is over modulation?
3. Why is FM more immune to the effects of noise?
   How many sidebands are present in the spectrum of FM wave ideally? What is Carson's rule? The modulation index of an FM wave is 10 and the highest modulation frequency is 20kHz. Find the minimum bandwidth required for the detection of this FM wave.
4. What is the need of sampling? Define Nyquist sampling theorem.
   For the given signal $m(t) = \frac{1}{2\pi}[cos(4000\pi t)cos(1000\boldsymbol{\pi t})]$, determine the Nyquist rate and Nyquist interval.
5. Describe in brief CDMA technology in wireless communication system. List the advantages of TDMA over CDMA
6. What is binary phase shift keying(BPSK)? In a BPSK digital communication system, the bit rate of a data sequence is 1 Mbps and carrier frequency of transmission is 100 MHz. Determine the symbol rate of transmission and the bandwidth requirement of the communications channel.
7. Sketch the digitally modulated waveforms for the binary data 110101 using ASK and FSK. What are the advantages of digital modulation over analog modulation?
8. What do you mean by the term azimuth and elevation angle of a satellite? Mention the advantages and disadvantages of satellite communication. Why is the uplink frequency greater than the downlink frequency in satellite communication?
9. Describe in brief various types of noises which may affect the communication system.
10. With the necessary circuit diagram, explain in brief the working of an emitter modulator to generate an AM waveform.

B.Sc. Semester-V (Honours) Examination, 2021 (CBCS)
Subject: Physics
Paper: DSE-2 (Nano Materials and Applications)

Time: 2 Hours **Full Marks: 40**

The questions are of equal value. Candidates are required to give their answers in their own words as far as practicable.

Answer any ***eight*** of the following questions 5 x 8 = 40

1. Write three major differences between bulk materials and nanomaterials. Explain the properties and applications of nanodots in brief. Why carbon nanodots are considered as superior in this context?

2. What is a quantum wire? How many dimensions are confined in this case? For a quantum wire, sketch the density of states (DOS) as function of energy, E.

3. Explain molecular beam epitaxy (MBE) method for nanoparticle synthesis with a suitable diagram. Mention two advantages and two disadvantages of MBE method.

4. What is sol-gel process? What is the principle of operation of this process? What are advantages of this synthesis process?

5. Derive equation of Bragg's law from Laue's equations of X-ray diffraction. Hence use this equation to derive an expression for average particle size determination..

6. What is a transmission electron microscope (TEM)? Describe different modes of operation of TEM. What type of information can a TEM provide about the sample?

7. What is meant by point defects in crystals? State the difference between Schottky and Frenkel defects. Which one of these two changes the density of the solids?

8. Distinguish between direct band gap and indirect band gap materials with suitable examples. Why direct band gap material is preferred over indirect one for optical devices?

9. Describe briefly the applications of nanoparticle in medical science. What are the advantages of using nanoparticles in drug delivery?

10. What is magnetic quantum dot and in which way they are different from quantum dot? Write some of the major applications of magnetic quantum dot.

B.Sc. Semester-V (Honours) Examination, 2021 (CBCS)
Subject: Physics
Paper: DSE-2 (Classical Dynamics)

Time: 3 Hours **Full Marks: 60**

Answer any **twelve** questions 12 x 5 = 60

1. Suppose a charged particle enters in a uniform magnetic field with velocity v_o along y-axis and the field is directed along z-axis. Obtain the equation of the path of the particle. Show that the gyro-frequency of the particle is independent of the velocity of the particle.
2. (i) What is cyclic coordinate? Show that the conjugate momentum of a cyclic coordinate is a conserved quantity.
   (ii) The Lagrangian of a particle is $L = \dot{q}^2 - q\dot{q}$. Show that the particle moves freely.
3. The bob of a simple pendulum moves in a horizontal circle. Write down the Lagrangian of the system. Obtain the Lagrange's equation of motion and hence find the angular frequency of the circular motion.
4. State Hamilton's principle. Using this derive Euler-Lagrange's equation.
5. (i) If the Hamiltonian does not depend explicitly on time then prove that total energy is a constant of motion.
   (ii) A dynamical system with generalised coordinates q_1 and q_2 has Lagrangian $L = \dot{q}_1^2 + \dot{q}_2^2$. If p_1 and p_2 are the conjugate momenta obtain the Hamiltonian of the system.
6. (i) The potential of a system is $V(x) = x^2 - x^4$. Find the position of stable and unstable equilibrium.
   (ii) The Lagrangian of two coupled harmonic oscillators is
   $$L = \frac{m}{2}(\dot{x}_1^2 + \dot{x}_2^2) - \frac{k}{2}[(x_2 - x_1)^2 + x_1^2]$$
   where m and k are constants. Find normal frequencies of the system.
7. What are length contraction and time dilation in special theory of relativity?
   Calculate the length and orientation of a rod of length 5 m in a frame moving with velocity 0.6 c in a direction making an angle 30^o with the rod.
8. Write down Lorentz transformations in Minkowski representation (x, w = ct).
   Explain the length contraction using Minkowski diagram.
9. In four-vector representation $(\vec{r}, ict)$ write down the interval between two world points. What is space-like interval? What can you say about the causal relation between two world points in space-like interval? Show that four-force and four-velocity vector are orthogonal to each other.
10. What is proper time? Define four-velocity vector. Show that it is an invariant quantity and is time-like.
11. Write down four-momentum transformation equations. Explain the Doppler effect using four-momentum representation.
12. Define streamline motion and critical velocity of fluid. What is Reynold's number?
    The cross-sectional radius of a pipeline decreases as $r = r_o e^{-ax}$, where a = 0.6 m^{-1} and x is the distance (in m) from the pipeline inlet. Calculate the ratio of Reynold's number for two cross-sections separated by $\Delta x = 3$ m.

13. State Newton' law of fluid. Hence, define the coefficient of viscosity of a fluid. Water (coefficient of viscosity is 0.01 Poise) is flowing through 50 cm long tube. The first 25 cm of the tube is of radius 1 mm and remaining 25 cm is of radius 2 mm. If the pressure difference maintained at the two ends is 20 cm of water calculate the amount of water flowing out per second through the tube.
14. What is central force field? A particle moves under a central force field. Set up the Hamiltonian of the system. Hence obtain the Hamilton's equations of motion.