B. Sc. Semester V (Honours) Examination, 2020 (CBCS)

Subject: Physics

Paper: DSE-2(1) (Nano Materials and Applications)

Time: 2 Hours Full Marks: 40

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*Candidates are required to give their answers in their own words as far as practicable*

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

1. How does nanosize influence different properties of a material? Bulk gold is yellow but nanogold is never yellow-Why is it so?

2. What is the condition of quantum confinement?

An electron of energy 342 eV is confined in a one-dimensional box of length 1Å. Calculate (I) the quantum number 'n' of the energy state of the electron and (II) the energy required to take the electron to the next higher state.

3. Distinguish between top down and bottom up approach for nanomaterial synthesis. Give examples in each case. What are the main disadvantages of top down and bottom up approaches?

4. What is chemical vapour deposition (CVD) technique for thin film preparation? What are different CVD techniques? State some uses of CVD.

5. What information we can obtain by analysing XRD pattern of a crystal? Why the position of H atom cannot be determined from XRD?

X-rays of wavelength 0.71Å are reflected from the (110) plane of a NaCl crystal of lattice constant $a$ = 2.82Å. Calculate the corresponding glancing angle for 2nd order reflection.

6. What is a scanning electron microscope (SEM)? Draw the schematic diagram and mention the essential components of a SEM. What are the various signals produced by SEM regarding microstructure and chemical analysis of a nanomaterial?

7. Define Quasi-particles regarding microstructure and chemical analysis of nanomaterials?. Distinguish between Quasi-particles and real particles. How can you justify polaron as a Quasi-particle?

8. What is a quantum dot? Why is it called an artificial atom? Explain briefly Coulomb blockade effect in connection to quantum dot.

9. What are the basic differences between NEMS and MEMS? How are they fabricated? Write some of the applications of MEMS in medical science.

10. Discuss briefly the major applications of quantum dots in solar cells. What are the advantages and disadvantages of quantum dot solar cell?

# OR

**B. Sc. Semester V (Honours) Examination, 2020 (CBCS)**

**Subject: Physics**

**Paper: DSE-2 (Communication Systems)**

**Time: 2 hrs** **Full Marks: 40**

*Candidates are required to give their answers in their own words as far as practicable*

Answer *any eight* of the following question: 8×5 = 40

1. An amplitude modulated voltage is given by

$$v(t) = 50\cos 10^6 t[1 + 0.4\cos 200t + 0.02\cos 4000t]$$

Find all frequency components in Hz, find the modulation index for each term, bandwidth and power in side bands.

2. What is the basic difference between analog and digital communication? Write the advantages and disadvantages of a Digital Communication System.

3. How can a slope detector be employed to detect FM waves? What is its disadvantage?

4. Explain the principle of operation of cellular telephone network. Why hexagonal shape is preferred for cell site?

5. Define the following terms for FSK modulation: frequency deviation, modulation index and deviation ratio.

6. Explain the term sampling and quantizing in pulse code modulation. Derive an expression of SNR for linear quantization.

7. How are the shortcomings of a straight forward AM radio receiver eliminated in super heterodyne radio receiver? Explain super heterodyne receiver with basic block diagram.

8. Using Kepler's law, estimate the orbital velocity of a Geosynchronous satellite and hence estimate round trip propagation delay between a satellite and an earth station located just below it. What are the advantages and disadvantages of Geosynchronous satellites?

**9.** What are the common sources of information? What is meant by channel bandwidth? What is the function of a carrier in a modulation system?

10. What are the various transducers used in communication systems? Define a communication channel and name different types of communication channels.

# OR

## B. Sc. Semester V (Honours) Examination, 2020 (CBCS)

Subject: Physics

Paper: DSE-2

(Classical Dynamics)

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

Answer any **12** questions (All questions carry equal marks): 5×12=60

1. A particle of mass m is constrained to move on a spherical surface of radius R under gravity. Mention the generalised coordinates. Construct the Lagrangian of the system and hence obtain the equations of motion of the particle. Mention the conserved quantities

2. Define the Hamiltonian of a system. Hence, obtain Hamilton's equations of motion. What is the physical significance of Hamiltonian of a system?

3. What do you mean by "closed system"? Prove that the angular momentum of a closed system is a conserved quantity in isotropic space.

4. The Lagrangian of two coupled harmonic oscillators is

$$L = \frac{m}{2}(\dot{x}_1^2 + \dot{x}_2^2) - \frac{k}{2}[(x_1 - x_2)^2 + x_1^2 + x_2^2].$$

Write down the Lagrange's equations of motion. Hence, find normal frequencies and ratio of amplitudes of the masses for each normal mode of vibration.

5. A charged particle is at rest at origin. A constant electric field is applied along y-direction and a constant magnetic field is applied along z-direction. Show that the path of the particle is cycloid in x-y plane.

6. The Lagrangian of a particle in cylindrical coordinate is

$$L = \frac{m}{2}(\rho^2\dot{\phi}^2 + \dot{z}^2) - \frac{k}{2}(\rho^2 + z^2).$$

Obtain the Hamiltonian of the system and hence find the canonical equations of motion of the particle. Mention the cyclic coordinate.

7. If the Lagrangian is added with a total time derivative of a function of coordinate q and time t then show that the equation of motion remains unaltered.

Show that the Hamiltonian of a system is the total energy for velocity independent potential.

8. Write down the Lorentz transformations in special theory of relativity.

A rocket accelerates quickly and then moves at a uniform velocity. Calculate the velocity of rocket relative to earth such that it reaches a star at a distance 15 light years away in one year as measured by a clock at rest in rocket.

9. Consider the world as two dimensional space-time system (x, w = ct). Write down the Lorentz transformations in terms x and w.

What is world line? Draw the world line of light and a particle in (x, w) plane.

10. A rod of length $l_o$ is at rest in an inertial frame $S'$. The rod is inclined at an angle $\theta'$ with $x'$ axis of $S'$. What is the length of rod in S if $S'$ moves with uniform velocity v with respect to S along common x-axis?

Show that $\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}-\frac{1}{c^2}\frac{\partial^2}{\partial t^2}$ is an invariant quantity under Lorentz transformations.

11. Define four-velocity vector. Hence, obtain the expression of four-acceleration in terms of acceleration vector and velocity vector.

12. In 4-vector representation show that the Lorentz transformation is equivalent to a rigid rotation through an imaginary angle of Caertesian axes. Using this obtain the Einstein's law of addition of velocities.

13. Deduce the equation of continuity for fluid motion. Express the equation of continuity for incompressible fluid in absence of source or sink. Show that for irrotational flow of incompressible fluid the velocity potential satisfies Laplace's equation.

14. What is viscosity of fluid? Derive Poiseuille's equation for flow of incompressible fluid.