R6368	Sub. Code
	542101

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2021

First Semester

Materials Science

MATHEMATICAL PHYSICS

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A $(10 \times 2 = 20)$

Answer **all** questions.

1. State Gauss theorem.

2. Find the inner product of the vectors (1, 2, 3) and (3, -5, 6).

3. What are the different forms of Beta function?

4. Write any two-recurrence relation For Hermite Function.

5. State Cauchy's Integral theorem.

6. Find the Residues of $f(z)=\frac{z}{(z-1)(z-2)}$ at its poles.

7. Define the linearity property of Laplace transform.

8. What is convolution theorem?

9. Write the diffusion equation in heat transfer.

10. What is meant by irreducible representation of a group?

Part B (5 × 5 = 25)

Answer **all** questions, choosing either (a) or (b).

11. (a) From the set of vectors $(1, 0, 0), (1, 0, 1)$ and $(0, 1, 1)$ construct a set of orthonormal vectors.

Or

(b) Show that the Eigen values of a Hermitian matrix are real and its Eigen vectors corresponding to two distinct Eigen values are orthogonal.

12. (a) Derive Bessel's equation from Legendre differential equation.

Or

(b) Obtain the Fourier transformation of Dirac delta function.

13. (a) Derive the necessary conditions for Cauchy's Riemann differential equation.

Or

(b) Define the Laurent's series singularity in detail.

14. (a) Explain convolution theorem in detail.

Or

(b) Find the Laplace transform of

(i) $J_0(t)$ (ii) $J_0(at)$

(iii) $J_1(t)$.

15. (a) State and derive the transverse vibration of string.p.

Or

(b) Explain the reducible and irreducible representations and mention their main features.

Part C

$(3 \times 10 = 30)$

Answer any **three** questions.

16. State and prove Green's theorem.

17. State and prove the orthonormality property of Bessel's functions.

18. Find the Taylor expansion of $f(x)=\frac{1}{1+z^2}$ at $z=1$. The function is analytic inside $|z-1|<\sqrt{2}$.

19. Discuss the Laplace transformation properties and its derivatives.

20. Explain the physical applications of Group theory.

R6369	Sub. Code
	542102

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2021

First Semester

Materials Science

CLASSICAL MECHANICS AND STATISTICAL THERMODYNAMICS

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A $(10 \times 2 = 20)$

Answer **all** questions.

1. State the principle of virtual work.

2. What are cyclic coordinates? Mention its consequence.

3. What is Canonical Transformation?

4. Define Lagrange's bracket.

5. Derive the ratio of specific heat γ for diatomic gas.

6. The mean free path of the particles of a gas at Temperature T_0 and pressure P_0 has a value λ_0. (mean free path). If the pressure is increased to 1.5 P_0 and the temperature is reduced to 0.75 T_0 then find the mean free path.

7. Mention any two differences between classical statistics and quantum statistics.

8. How do you connect micro-states and macro-states in the micro-canonical ensemble picture?

9. What is meant by Strong degeneracy?

10. What is the minimum energy that has to be Supplied to the electron for its emission in the metal?

Part B $(5 \times 5 = 25)$

Answer **all** questions choosing either (a) or (b).

11. (a) Setup Lagrangian and derive Euler Lagrange's equation of notion of a linear harmonic oscillator obtain the general solution for it.

Or

(b) Deduce Hamilton's equation of motion from Hamilton's principle for holonomic system.

12. (a) Derive the kinetic energy of a rigid body in space.

Or

(b) Define Action angle variables with example. Mention uses of this formalism.

13. (a) Define the thermodynamic potentials

(i) Enthalpy,

(ii) Helmholtz

(iii) Gibbs. What is the significance of them?

Or

(b) Derive Bose-Einstein distribution law.

14. (a) What is a Fermi gas? Deduce an expression for energy of a Fermi gas at absolute zero.

Or

(b) Obtain an expression for partition function in Gibb's canonical ensemble.

15. (a) Discuss Einstein's model of specific heat of solids.

Or

(b) Derive an expression for the equipartition energy.

Part C $(3 \times 10 = 30)$

Answer any **three** questions.

16. Deduce Lagrange's equation of motion from D' Alembert's principle for both conservative and non-conservative systems.

17. Obtain Euler's equation of motion for a rotating rigid body. What information these equations provide when the motion of the rigid body is not subjected to any force?

18. Derive Maxwell's thermo dynamical relations.

19. Write notes on canonical and grand canonical ensemble.

20. Apply Bose-Einstein statistics to black body radiation problem and derive Planck's law.

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R6370	Sub. Code
	542103

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2021

First Semester

Materials Science

ELECTRONICS AND INSTRUMENTATION

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A $(10 \times 2 = 20)$

Answer **all** questions.

1. Define CMRR.
2. A power amplifier gives 150W output for an input of 1.5W. Determine the gain in db.
3. Define resolution in A/D converter.
4. What is meant by RAM?
5. What is the fiber acceptance angle when n_1 = 1.46 and n_2 = 1.44?
6. A photodiode has a responsivity of 0.5 A/W at 850 nm. Find the efficiency of the detector.
7. Define Transducers.
8. Define signal conditioning.
9. List out any two Applications of Nanotechonolgy in electronics
10. What is single electron transfer devices?

Part B (5 × 5 = 25)

Answer **all** questions, choosing either (a) or (b).

11. (a) Explain how Op-Amp can be used as an inverting Amplifier.

Or

(b) Explain how an op-amp works in integrator.

12. (a) Construct the ring counter and explain its function.

Or

(b) Explain the action of R-2R ladder in D/A conversion.

13. (a) A single solar cell on illumination by irradiation of about 800 W/m^2 produces a voltage of 0.5V and a current up to 2.0 A. The efficiency of the solar cell is 12.5%, find the area of the cell.

Or

(b) A photodetector has a quantum efficiency of 80% at 1000 nm. A radiation of optical power 0.01 watt/m^2 at this wavelength is incident on the device which has a receiving area of 1 mm2. The detector has a dark current of 5 nA and a shunt resistance of 10^8 ohms. If the bandwidth of operation is 100 MHz, calculate the power SNR of the detector.

14. (a) Discuss the different types of transducers.

Or

(b) Sketch basic building blocks of instrumentation system.

15. (a) Write short notes on

(i) NEMS

(ii) memory storage

Or

(b) Describe the working of resonant tunneling diodes with a neat diagram.

Part C

$(3 \times 10 = 30)$

Answer any **three** questions.

16. Construct the following with neat diagram
    (a) Low pass filter
    (b) High pass filter.

17. Explain the following counters
    (a) Synchronous
    (b) Asynchronous.

18. Describe the construction and working of optoelectronic modulation and switching devices.

19. Describe basic Data Acquisition System with neat and labeled sketch.

20. Discuss the parameters and characteristics of MOSFET.

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R6371

Sub. Code
542104

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2021

First Semester

Materials Science

ELECTROMAGNETIC THEORY AND OPTICS

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A $(10 \times 2 = 20)$

Answer **all** questions.

1. State Faraday's Laws of electromagnetic induction.

2. Three charges are located on the circumference of a circle of radius R. The two charges Q subtend an angle 90° at the centre of the circle. The charge q is symmetrically placed with respect to the charges Q. If the electric field at the centre of the circle is zero, what is the magnitude of Q?

3. An electromagnetic wave is incident on a water-air interface. The phase of the perpendicular component of the electric field, $E_{\perp}$, of the reflected wave into the water is found to remain the same for all angles of incidence. Determine the phase of the magnetic field H.

4. Define Poynting vector.

5. Give any two properties of negative crystal.

6. Define Biaxial media.

7. State the principle of Magneto-optical effects.

8. Give any two applications of SBS.

9. State the principle of frequency conversion.

10. Define optical switching

Part B $(5 \times 5 = 25)$

Answer **all** questions choosing either (a) or (b).

11. (a) Write down Maxwell's equations in differential and integral forms.

Or

(b) A circular antenna of area 3 m^2 is installed at a place. The plane of the area of antenna is inclined at 47° with the direction of Earth's magnetic field. If the magnitude of Earth's field at that place is 40773.9 nT find the magnetic flux linked with the antenna.

12. (a) An observer now moves at a velocity of $v = c/4$ toward the oncoming wave. What will he measure for the wavelength λ and the frequency f of the wave?

Or

(b) Derive an expression for the velocity of propagation of a plane electromagnetic wave in an isotropic medium.

13. (a) Discuss the Light propagation in anisotropic media.

Or

(b) Write a short note on

(i) Index ellipsoid

(ii) Wave plates

14. (a) Illustrate the theory for derivation of sum and frequency generation.

Or

(b) Discuss the theory and application of stimulated Raman scattering (SRS)

15. (a) Describe the principle and working of optical bi-stability.

Or

(b) Elaborate the theory and working of phase conjugation.

Part C $(3 \times 10 = 30)$

Answer any **three** questions.

16. State and prove Ampere's circuital law in circuital form.

17. Discuss the propagation of plane electromagnetic waves in an isotropic dielectric medium. Show that Electric and magnetic field vectors, E and H are mutually perpendicular.

18. Write a brief note on

(a) Electrical conductivity tensor

(b) Stress optic tensors

19. Discuss the principle and theory of Magneto-optical Kerr and Faraday effect.

20. Illustrate the theory and applications of non-linear effects.

R6372	Sub. Code
	542502

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2021

First Semester

Materials Science

MOLECULAR ELECTRONICS

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A $(10 \times 2 = 20)$

Answer **all** questions.

1. What are the different dimensions of nanomaterials? Give example.

2. The diameter of Zinc atom is 2.6 Å.

   (a) Calculate the radius of Zinc atom in pm.

   (b) Number of atoms present in a length of 1.6 cm if the zinc atoms are arranged side by side lengthwise

3. What is CNT?

4. How does carbon nanotube interconnects?

5. Why network contacts are important in devices?

6. Define Robots?

7. What are photochromic switches?

8. Write short note on assembly of DNA molecule.

9. Give any two applications of plastic electronics?

10. Define OLEDs.

Part B $(5 \times 5 = 25)$

Answer **all** questions, choosing either (a) or (b).

11. (a) Write short notes on the classification of nanostructures and its applications.

Or

(b) Explain the top-down approach of nanomaterial preparation with an example.

12. (a) What is fullerene? How it can be synthesized and purified.

Or

(b) Why carbon nanotubes are used in hydrogen storage materials? Discuss in detail.

13. (a) How electrodes are classified? List out the different types.

Or

(b) Describe random access memory.

14. (a) What are the advantages and disadvantages of biomolecular computing?

Or

(b) Is DNA an electrical conductor? Explain its role in biomolecule computing.

15. (a) Write a brief note on donor and acceptor molecules.

Or

(b) What are the organic components used in the emissive layer of OLEDs?

Part C

$(3 \times 10 = 30)$

Answer any **three** questions.

16. Compare the advantages and disadvantages of top down and bottom-up approaches in nanomaterial preparations. Explain any two methods for each.

17. What are CNTs? Briefly explain their structures and properties.

18. What is circuit simulation? Explain its types and applications in nanoelectronics devices.

19. What is charge transfer complex? Explain the methods of charge transfer and discuss the charge transfer rate in solution in detail.

20. Explain the various flexible materials that are used in the opto-electronic devices. Justify their electrical and optical properties for the same.

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