R6768	Sub. Code
	542201

M.Sc. DEGREE EXAMINATION, APRIL – 2022

Second Semester

Material Science

NUMERICAL METHODS FOR MATERIALS SCIENCE

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

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

Answer **all** questions.

1. Define memory management function in MATLAB.
2. What is Simulink?
3. Evaluate $\sqrt{15}$ using Newton Raphson's formula.
4. Give two direct methods to solve a system of linear equations.
5. What are the advantages of cubic spline fitting?
6. State Newton's backward formula for interpolation.
7. What are the errors in Simpson's rule of numerical integration?
8. State three-point Gaussian quadrature formula.
9. State the advantages and disadvantages of the Taylor's series method.
10. Write down the finite difference scheme for solving $y''+x+y=0;\ y(0)=y(1)=0$.

Part B (5 × 5 = 25)

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

11. (a) Discuss how a source code can be executed on MATLAB.

Or

(b) List out the operators that MATLAB allows and explain with example.

12. (a) Using Newton – Raphson method find a positive root of the equation $3x - \cos x - 1 = 0$.

Or

(b) Compare Seidel and Newton's method for a single equation.

13. (a) Find a polynomial of degree two for the data by Newton's forward difference formula.

x:	0	1	2	3	4	5	6	7
y:	1	2	4	7	11	16	22	29

Or

(b) Find the cubic spline in the interval $1 \le x \le 2$ and hence evaluate $y(1.5)$ by using the following data:

x:	1	2	3	4
y:	1	2	5	11

14. (a) Evaluate $\int_0^{\frac{1}{2}} \frac{x}{\sin x}\,dx$ correct to three decimal place using Romberg's method.

Or

(b) Using Simpson's 1/3 rule, evaluate $\int_0^1 \int_0^1 \frac{dxdy}{1+xy}$ with $h = k = 0.25$.

15. (a) Solve $y' = x + y; y(0) = 1$ by Taylor series method. Find the values of y at $x = 0.1$ and $x = 0.2$.

Or

(b) Explain Monte Carlo integration for generating Random numbers.

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

Answer any **three** questions.

16. Explain about MATLAB basic syntax, cell array and writing a MATLAB program with an example.

17. Apply Gauss – Seidal method to solve the system of equations.

$20x + y - 2z = 17;$

$3x + 20y - z = -18,$

$2x - 3y + 20z = 25$

18. Find the polynomial (the Newton interpolating polynomial) which interpolates the data given in Table (the gas problem). Use this polynomial to estimate the volume of gas at pressure 1.75.

x:	1.62	1.00	0.75	0.62	0.52	0.46
y:	0.5	1.0	1.5	2.0	2.5	3.0

19. Using Trapezoidal rule evaluate $\int_0^1 \int \frac{dxdy}{x+y+1}$ with h=0.5 along x direction and $k = 0.25$ along y direction..

20. Using Runge Kutta method of fourth order, find the value of y at $x = 0.2, 0.4, 0.6$ given $\frac{dy}{dx} = x^3 + y, y(0) = 2$. Also find the value of y at 0.8.

R6769	Sub. Code
	542202

M.Sc. DEGREE EXAMINATION, APRIL – 2022

Second Semester

Materials Science

CHARACTERIZATION OF MATERIALS

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

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

Answer **all** questions.

1. How DTA technique is different from DSC? Write the main application of both the techniques.

2. In ———— type DSC the temperature of the sample and reference are controlled independently using separate furnace.

3. What is the ratio of resolving power of an optical microscope for wavelengths, = 4000 Å and = 6000 Å?

4. What is the resolving power of light microscope and what does it depends on?

5. Topographical image of a multiphase sample surface is possible by STM in ———— Mode.

6. Differentiate between thermionic emission gun and field emission gun with respect to TEN.

7. A Ge specimen is doped with Al. The concentration of acceptor atoms is atoms. Given that the intrinsic concentration of electron hole pairs is atoms. What is the concentration of electrons in the specimen?

8. What is the difference between cathodic peak potential and anodic peak potential value in cyclic voltammetry?

9. On which factors the vibrational stretching frequencies of diatomic molecule depend?

10. What is the absorbance of an IR peak with a 17% transmittance?

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

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

11. (a) What is meant by thermogravimetric analysis and how it is helpfiul in describing various properties of materials?

Or

(b) Draw Differential Scanning Calorimetry (DSC) Curves for 5 grams and 10 grams lead from room temperature to 500°C at constant heating rate of 10°C per minute.

12. (a) Give an account of differential interference contrast microscopy.

Or

(b) Calculate the resolution and the depth of field of the objective lenses of a light microscope, listed below. The refractive index of vacuum is 1, and that of air can be treated as 1. Assume blue light is used in the microscope.

Magnification/NA

5 × / 0.13

10 × / 0.25

20 × / 0.40

50 × / 0.70

50 × / 0.90

13. (a) Explain the working principle of AFM with neat sketch. What is the need of AFM when scanning electron microscope is available?

Or

(b) Calculate the minimum probe size of an electron beam with an energy of 20 key, probe current of 3 mA, the brightness of 3.04×10^9 A.cm^{-2}.sr^{-1}, and a spherical aberration of 2 mm (take K = 1 and $\lambda = 0.008$ um).

14. (a) Write a short notes on photoluminescence.

Or

(b) An n-type silicon semiconductor (with an intrinsic carrier concentration is 9.65×10^9 cm^{-3}) has its Fermi level at 0.19 eV below the conduction band edge at thermal equilibrium at 300 K.

(i) What is the concentration of dopant atoms in the semiconductor? (1)

(ii) Calculate the minority carrier concentration in the semiconductor at thermal equilibrium. (2)

(iii) Calculate the majority and minority carrier concentrations (also at 300 K) after the n-type semiconductor bad been uniformly-doped with boron atoms to a concentration of 8.5×10^{18}cm^{-3}. (2)

15. (a) Give an account of how Raman spectra provides valuable information about the molecular structure and other parameters of diatomic molecule.

Or

(b) The vibrational wavenumbers of the following molecules in their $v = 0$ states are HCl : 2885 cm^{-1}, DCl : 1990 cm^{-1}, D_2 : 2900 cm^{-1} and HD : 3627 cm^{-1}. Calculate the energy change, in kJ mol^{-1} of the reaction.

$HCl + D_2$ DCl + HD

And determine whether energy is liberated or absorbed.

Hint : Consider the zero point energies of the four molecules concerned.

Part C

$(3 \times 10 = 30)$

Answer any **three** questions.

16. Explain the working principle of DTA, DSC and TGA in detail and compare them?

17. (a) What are metallurgical microscopes used for? (2)

    (b) What is magnifying power of metallurgical microscope? (3)

    (c) Also describe the differences between confocal and fluorescence microscopy? (5)

18. Explain in detail about scanning tunneling microscope (STM) and Atomic force microscope (AFM) and write four differences between them.

19. How can a Hall probe be used to measure a magnetic field and describe the experimentation?

20. Discuss the principle of NMR Spectroscopy and explain how this technique is used in elucidating the structure of the molecules.

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R6770	Sub. Code
	542203

M.Sc. DEGREE EXAMINATION, APRIL 2022

Second Semester

Material Science

QUANTUM MECHANICS

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

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

Answer **all** questions.

1. Define momentum operator?

2. Define Eigen values?

3. What is quantum tunneling?

4. Determine the electron's de Broglie wavelength and momentum, when k = 50 nm - 1

5. What are the angular momentum operator?

6. What is range of Azimuthal quantum number.

7. Write down Pauli matrices for σ_x and σ_y ?

8. Spring is attached to a mass, oscillating freely in simple harmonic motion. What change can be made to increase the period of the oscillation?

9. What are the partial wave?

10. Draw the scattering diagram for the probability density $|\psi|^2$ of wave packet with $\langle E \rangle = E_0$ and finite square barrier of height V_0 when $E_0 > V_0$.

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

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

11. (a) What are the inadequacy of the classical mechanics?

Or

(b) Write down the formula for the expectation values of measurable quantities and explain its notations?

12. (a) Explain why the energy of a quantum particle in a box is quantized.

Or

(b) What is rigid rotator and state the importance of studying it?

13. (a) Explain commutation rules in quantum mechanics?

Or

(b) Find out commutator of L_x and L_y?

14. (a) Brief the Fermi Golden rule?

Or

(b) Explain mechanism of stark effect?

15. (a) Explain scattering cross section.

Or

(b) Discuss the partial wave analysis of scattering.

Part C

$(3 \times 10 = 30)$

Answer any **three** questions.

16. Discuss the stationary state in quantum mechanics using Schrodinger time-dependent equation?

17. Explain wave equation for linear harmonic oscillator and its solution?

18. Derive Clebsch-Gordon coefficients for j=1/2 system?

19. Drive the first order time independent perturbation theory?

20. Discuss the theory of Born approximation. Explain in detail.

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R6771	Sub. Code
	542204

M.Sc. DEGREE EXAMINATION, APRIL – 2022.

Second Semester

Materials Science

PHYSICS OF MATERIALS

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

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

Answer **all** questions.

1. How can you determine the shear strength of perfect and real crystals?

2. What is meant by creep? Explain.

3. Explain the types of polarizations with relevant expressions.

4. Calculate the polarization of a $BaTiO_3$ crystal. The shift of the titanium ion from the body centre is 0.12 Å. The oxygen anions of the side faces shift by 0.12 Å. white the oxygen anions of the top and bottom faces shift by 0.16 Å, all in a direction opposite to that of the titanium ion.

5. A transformer core is wound with a coil carrying an alternating current at a frequency of 250 Hz and assuming the magnetization to be uniform throughout the core volume of 0.01 m^3, calculate the hysteresis loss. The hysteresis loop has an area of 30000 units, when the axes are drawn in units of 10^{-4} Wb m^{-2} and 10^2 Am^{-1}.

6. What is meant by magnetic bubbles? What is its application?

7. Describe the origin of luminescence.

8. What are the super luminescent LED materials? How do they differ from ordinary LED?

9. How can you differentiate magnetostrictive and electrostrictive materials?

10. Briefly discuss about the rheological fluids.

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

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

All question carry equal marks.

11. (a) The activation volume for dislocation motion in a crystal is $20b^3$, where b is the Burgers vector of the moving dislocation. b = 2Å. The P-N stress for this crystal is 1000 MN m^{-2}. For a specified rate of dislocation motion, the activation energy Q = 40 kT. Calculate the stress required to move the dislocation at (i) 0 K, (ii) 100 K, (iii) 200 K, (iv) 400 K and (v) 600 K.

Or

(b) What are the methods generally employed for strengthening against plastic yield?

12. (a) The electronic polarization of W is $4\times10^{-7}\ Cm^{-2}$, calculate the average displacement of the electrons relative to the nucleus (Given: Atomic no. of W=74; crystal type: BCC; a = 3.16Å)

Or

(b) Discuss the physics involved in (i) Different types of ferroetectric materials and (ii) Piezoelectric materials,

13. (a) Calculate the saturation magnetization of magnetite. The unit cell of magnetite is cubic with a lattice parameter of 8.37 Å and it contains 16 ferric and 8 ferrous ions in the unit cell.

Or

(b) Write notes on: (i) GMR materials and (ii) DMS materials.

14. (a) A GaAs infrared LED emits at about 890 nm and this is detected using a Si photo-detector. What should be the thickness of the Si crystal to absorb most of this radiation?

Or

(b) Compare the LC and LED displays.

15. (a) What are the SMART materials? Briefly discuss the types.

Or

(b) The wavelength range of visible light is 4000-7000 Å. What is the minimum energy band gap for a semiconductor to adsorb (i) in visible range, (ii) above the visible range, and (iii) below the visible range?

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

Answer any **three** questions.

16. (a) Write notes on the types of fractures and explain about the various methods to avoid fractures. (5)

(b) The temperature and strain rate dependence of yield stress in MN m^{-2} for molybdenum is given by $\sigma_y = 20.6 + 173600/T + 61.3\log 10(d\varepsilon/dt)$ where T is the temperature in K and $(d\varepsilon/dt)$ is the strain rate in s^{-1}, Sharp cracks of half length $2\mu m$ are present in the metal. Estimate the temperature at which the ductile to brittle transition occurs at a strain rate of (i) $10^{-2}s^{-1}$ and (ii) $10^{-5}s^{-1}$. Y = $350\,GN\,m^{-2}$ and specific surface energy is $2\ \mathrm{J}\,m^{-2}$. (5)

17. Derive

(a) Claussius -Mossotti equation and (6)

(b) discuss its limitations and applications (4)

18. Discuss the following theories:

(a) Langevin and Weiss theories and (5)

(b) Molecular orbital theory of magnetism. (5)

19. Write a detailed account on optical adsorption in:

(a) insulators (2)

(b) semiconductors and (2)

(c) metals (2)

(d) discuss the fundamental theories. (4)

20. Give a detailed picture of the different types of solar cell materials and their applications.

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R6772	Sub. Code
	542511

M.Sc., DEGREE EXAMINATION, APRIL – 2022

Second Semester

Material Science

CORROSION SCIENCE AND ENGINEERING

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. Write short note on aqueous corrosion process.

2. Crevice corrosion is accelerated by deposition of dust or impurities. Why?

3. A piece of iron observed to exhibit a uniform corrosion rate of 10 mdd. What is the corrosion current density in A/cm^2?

4. What is in-vivo corrosion testing?

5. Distinguish between physical and chemical vapor deposition.

6. State the principle of plasma spraying technique.

7. How to rectify the corrosion in concrete?

8. What is the main source of corrosion in an aircraft?

9. Define the term abrasive materials.

10. Which material is used for thermal barrier coating?

Part B (5 × 5 = 25)

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

11. (a) Explain the thermodynamics aspects of corrosion process with Pourbaix diagram.

Or

(b) Describe high temperature oxidation and its impact on corrosion.

12. (a) Explain why surface preparation is more important in corrosion testing.

Or

(b) How corrosive is sea water and explain which metal is highly resistant to corrosion by sea water?

13. (a) Give brief account of flame spraying process.

Or

(b) Write short note on detonation gun spraying and explain the quality of films.

14. (a) What are the effects of corrosion in water? Explain the causes for corrosion?

Or

(b) Does corrosion affect human health? Explain why human body fluid is corrosive.

15. (a) Write short notes on (i) Abrasive and (ii) erosive coatings

Or

(b) How multilayer structure prevents corrosion and wear protection explain in detail?

Part C

$(3 \times 10 = 30)$

Answer any **three** questions.

16. Explain the Electrochemical Kinetics of corrosion. Describe cathode and anodic protection.

17. Illustrate the example the linear polarization method in corrosion testing.

18. Discuss in detail account of Electro deposition technique.

19. List out the corrosion in microelectronic industries and how it affects the device performance and explain its advantages and disadvantages

20. How coating prevents corrosion? Explain intermetallic barrier and thermal coating with example.

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