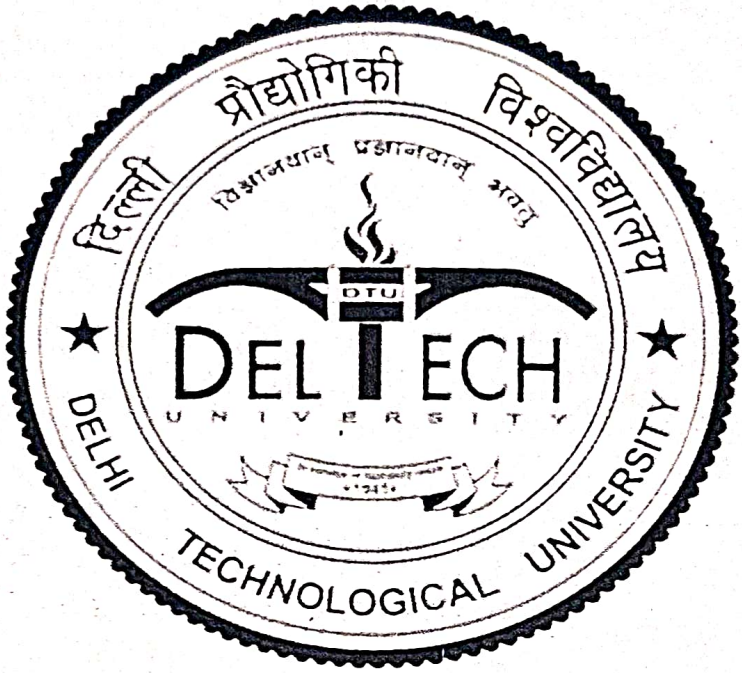
QUESTION PAPERS FOR END TERM THEORY EXAMINATIONS

November/ December-2022



M.Tech., MTPT, M.Sc., MBA, EMBA, M.Des.,

1st, 3rd & 5th SEMESTER

M.Sc.

S.no.	Department	Paper Code	Page No.
1.	AP	MSPH	203-221
2.	AC	MSCH	222-241
3.	AM	MSMA	242-260
4.	HU	MSHU	261
5.	BT	MSBT	262-280

203

Total No. of Pages: 2 *Roll No.....*

FIRST SEMESTER

M.Sc. Physics

END SEMESTER EXAMINATION *Nov. 2022*

MSPH-101: MATHEMATICAL PHYSICS

Time: 3 Hours *Max. Marks: 50*

Note: Attempt *Any Five* questions.
Assume suitable missing data, if any.

1. (a) Verify that the following is an inner product on R^2, where $u = (x_1, x_2)$ and $v = (y_1, y_2)$

$$f(u, v) = x_1y_1 - 2x_1y_2 - 2x_2y_1 + 5x_2y_2$$

[CO5] [5]

(b) Let G: $R^3 \to R^3$ be the linear mapping defined by

$$G(x, y, z) = (x + 2y - z, y + z, x + y - 2z)$$

Find a basis and the dimension of the image of G and the kernel of G. [CO5] [5]

2. (a) Verify Stoke's theorem for $\vec{A} = (x^2 + y - 4)\hat{\imath} - 3xy\hat{\jmath} + (2xz + z^2)\hat{k}$ over the surface of the hemisphere $x^2 + y^2 + z^2 = 16$ above the xy plane. [CO2] [7]

(b) Show that $\delta_j^i \delta_i^j = n$. [CO2] [3]

3. (a) The vibrations of an elastic string are governed by the partial differential equation

$$\frac{\partial^2 u}{\partial t^2} = \frac{\partial^2 u}{\partial x^2}$$

The length of the string is π and the ends are fixed. The initial velocity is zero and the initial deflection is $u(x, 0) = 2(\sin x + \sin 3x)$. Find the deflection $u(x, t)$ of the vibrating string for $t \geq 0$. [CO3] [6]

(b) Determine whether or not the following vectors in R^3 is linearly dependent:

$$u_1 = (1,2,5), u_2 = (1,3,1), u_3 = (2,5,7), u_4 = (3,1,4)$$

[CO5] [4]

204

4. (a) Show that the set of all positive rational numbers Q forms an abelian group under the composition defined by

$$a * b = \frac{(ab)}{2}.$$

[CO4] [5]

(b) Let I be the set of all integers and let R be the relation defined in I, such that xRy holds if $(x - y)$ is divisible by 5, $x \in I$, $y \in I$, i.e. $R = \{(x, y) : x \in I, y \in I, (x - y)$ is divisible by $5\}$. Show that R is an equivalence relation in I and determine all the possible equivalence classes in the set I with respect to relation R.

[CO4] [5]

5. (a) Prove that those elements of a group G which commute with the square of a given element b of G form a subgroup H of G and those which commute with b itself form a subgroup of H.
Set $H = \{x \in G: xb^2 = b^2x\}$ and Set $N = \{y \in G: yb = by\}$

[CO4] [5]

(b) Obtain the solution of the following wave equation, using the method of separation of variables:

$$\frac{\partial^2 v}{\partial x^2} = \frac{\partial v}{\partial t}$$

given that $v = 0$ when $t \to \infty$ as well as $v = 0$ at $x = 0$ and $x = l$.

[CO3] [5]

6. (a) Show that $\frac{\partial \phi}{\partial x^i}$ is a covariant vector where ϕ is a scalar function.

[CO2] [4]

(b) Determine the poles and residue at each pole of the function $f(z) = \frac{e^{zt}}{z^2(z^2+2z+2)}$.

[CO1] [6]

205

Total No. of Pages: 2

FIRST SEMESTER

END TERM EXAMINATION

Roll No.....

M.Sc. Physics

Nov.- 2022

MSPH-103: CLASSICAL MECHANICS

Time: 3 Hours *Max. Marks: 50*

Note: *Q1. is compulsory. Attempt Any four from the remaining questions.*
The marks assigned to questions are mentioned against them.
Assume suitable missing data, if any.

1. (i) If F and G are functions of position co-ordinates q_i and momentum co-ordinates p_i, define the Poisson's brackets of F and G. Prove that (a) [F,G] = - [G, F] and (b) $[q_i, p_j] = -\delta_{ij}$ (2) [CO3]

   (ii) What is a cyclic coordinate? Prove that Hamiltonian of a conservative system is equal to the total energy of the system. (2) [CO1]

   (iii) The motion of a system during at interval of time may be regarded as an infinitesimal contact transformation generated by Hamiltonian. Explain. (2) [CO1]

   (iv) What is a four vector? Show that scalar product of two four vectors is invariant under Lorentz transformations. (2) [CO4]

   (v) Investigate the stability of circular orbit of radius r_o, when a particle of mass m, moves under the influence of central force

   $$f(r) = \frac{-k}{r^2} + \frac{\alpha}{r^3}$$

   (2) [CO5]

2. (i)Derive Hamilton's canonical equations of motion. Using Hamilton's equations of motion, show that the Hamiltonian,

   $$H = \frac{p^2}{2m}e^{-rt} + \frac{1}{2}m\omega^2 x^2 e^{rt}$$

   leads to equation of motion of a damped harmonic oscillator $\ddot{x} + r\dot{x} + \omega^2 x = 0$ (5) [CO4]

   (ii) Obtain the Hamiltonian for an harmonic oscillator, whose Lagrangian is given by

   $$L(x, \dot{x}) = \frac{1}{2}\dot{x}^2 - \frac{1}{2}\omega^2 x^2 - ax^3$$

   (5) [CO5]

3. (i) Determine the canonical transformation defined by the generating function

   $$F_1(q, Q, t) = \frac{1}{2}m\omega(t)q^2 \cot Q$$

   Find also the new Hamiltonian, K. The old Hamiltonian is $H = \frac{p^2}{2m} + \frac{1}{2}m\omega^2 q^2$ (5) [CO3]

   (ii) Define Poisson bracket of two dynamical variables. For what values of m and n do the transformation equations :

   $$Q = q^m \cos np$$
   $$P = q^m \sin np$$

   present a canonical transformation? Obtain the generating function.

   (5) [CO5]

206

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4. (i) What is differential scattering cross-section? Discuss the problem of charged particles by a coloumb field and obtain Rutherford's formula for differential scattering cross-section. (5) [CO3]

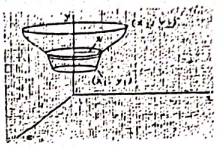
(ii) Derive the equation of orbit of a particle moving under the influence of a central force consistent with the inverse square law and discuss briefly the special cases depending upon the energy and hence of eccentricity. (5) [CO1]

5. (i) Discuss one dimensional harmonic oscillator problem, using Hamilton Jacobi method. (5) [CO3]

(ii) A bead slides without friction on a smooth wire which is rotating with angular velocity ω in the force free space. Find its Lagrangian equation of motion and also find its radial acceleration. (5) [CO4]

6. (i) What is Minkowski space? Show that the Lorentz transformations can be regarded as transformations due to a rotation of axes in the four – dimensional Minkowski space. Hence deduce the Lorentz transformation. (5) [CO3]

(ii) A curve passing through fixed points (x_1,y_1) and (x_2,y_2) and revolve about its Y-axis to form a surface of revolution. Find the equation of the curve for which the surface area is minimum. (5) [CO2]



5

207

Total No. of Pages: 2
FIRST SEMESTER
END SEMESTER EXAMINATION

Roll No.....
M.Sc. Physics
Nov. 2022

MSPH105: QUANTUM MECHANICS

Time: 3 Hours

Max. Marks: 50

Note: All questions carry equal marks.
Assume suitable missing data, if any.

Q.1 Write the time-independent Schrödinger equation for hydrogen atom and work out for its solution for radial part only. [10] [CO1]

Q.2(a) Show that the components of angular momentum do not commute in position space. [4] [CO3]

(b) Suppose you have a normalized wave function at $t = 0$, i.e., $\psi(x, 0)$. Show that it will stay normalized as time evolves. [6] [CO2]

OR

Q.3(a) Show that the commutation relation $[x, p_x] = i\hbar$ remains unchanged under a unitary transformation. [4] [CO3]

(b) Show that the vectors

$$A_1 = \begin{pmatrix} \cos\theta \\ \sin\theta \\ 0 \end{pmatrix}; A_2 = \begin{pmatrix} -\sin\theta \\ \cos\theta \\ 0 \end{pmatrix}; A_3 = \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}$$

form an orthonormal basis set. [6] [CO2]

Q.4 Obtain the Clebsch-Gordan (CG) coefficients for system of two non-interacting particles with angular momentum $j_1 = \frac{1}{2}$ and $j_2 = \frac{1}{2}$, and write the corresponding matrix. [10] [CO3]

208

Q.5 Illustrate the basic principle underlying the *Variational Method* and prove that the *ground state energy* is the *smallest* eigenvalue. [10] [CO5]

Q.6 Consider an electron inside an infinitely deep one-dimensional potential well.

$$V(x) = 0,\ 0 < x < L$$
$$= \infty \text{ for } x < 0 \text{ and } x > L.$$

The normalized wave functions are

$$\psi_n = \sqrt{\frac{2}{L}} \sin \frac{n\pi x}{L}.$$

Assuming a perturbation of the form $H' = -eFx$, show that in the first order perturbation theory, each energy level gets shifted by $-1/2\, eFL$. [10] [CO4]

OR

Q.7 Use a gaussian *trail* function, $\varphi(x) = Ae^{-bx^2}$, to calculate the ground state energy for the one-dimensional harmonic oscillator

$$H = -\frac{\hbar^2}{2M}\frac{d^2}{dx^2} + \frac{1}{2}m\omega^2 x^2,$$

by invoking the Variational method. [10] [CO4]

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Total No. of Pages: 2 Roll No. .....

FIRST SEMESTER M.Sc. (Physics)

END TERM EXAMINATION (Nov. 2022)

Course Code- MSPH 107 Course Title- Applied Optics

Time: 3:00 Hours Max. Marks: 50

Note: Question 1 is mandatory. (2 x 4 = 8 marks)
Answer any six from question 2-8. (7 marks each)
Assume suitable missing data, if any. Where symbols have their usual meaning

1. (a) A light from a 220-watt lamp uniformly spreads out in all directions. Find the intensity and the amplitude E_o of the E.M. waves at a distance of 10 m from the lamp.

(b) Calculate the distance between two successive positions of the movable plate in Fabry-Perot Interferometer for which we get coincidence of fringe system due to sodium light (λ_1 =5895.93 Å, λ_2 =5889.96 Å,).

(c) In a plane diffraction grating, width of opaque space is double the width of the transparent space. The number of lines per cm is 5000. Which order of the spectrum will be missing? Find the angular separation between the wavelengths 5460Å and 5480Å in the second order.

(d) Calculate the thickness of quarter wave plate with μ_o= 1.6247, μ_e= 1.5672 for λ=5893Å.

[CO#1-5]

2. What do you understand by double refraction? Describe the construction and working of Nicol Prism. How would you produce and detect the following using Nicol Prism and quarter wave plate: (a) plane polarized light, (b) circularly polarized light and (c) elliptically polarized light.

[CO#4]

3. Describe half period zones? What is zone plate? How the zone plate is constructed? Compare zone plate with convergent lens; also explain how a zone plate acts like a convergent lens having multiple foci.

[CO#5]

4. Derive the expression for the intensity of Fraunhofer Diffraction due to a single slit. Show that the intensities of first and second maxima are 1/22 and 1/61 of the intensity of the central maximum respectively.

[CO#5]

5. Discuss and derive Fresnel's integrals. Also, discuss Cornu's spiral with its application. [CO#5]

6. Explain the principle and theory of holography. Also, discuss the salient features and applications of holography. [CO#3]

7. Write Fourier series and describe Fourier transform theorem. Also, discuss its application in optics. [CO#3]

8. Define Poynting vector. Deduce theoretically Poynting theorem for the flow of energy in an electromagnetic field. [CO# 1]

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Total no. of pages: 03 *Roll No.....*

1st Semester

M.Sc.[Physics]

END TERM EXAMINATION NOV/DEC-2022

MSPH-109: Electronics

Max. Time=3:00 Hrs **Max.Marks=50**

1. Question No.1 is compulsory.
2. All questions carry equal marks.
3. Assume suitable missing data, if any.
4. Attempt any 5 questions out of 6 questions.

Q1. (a) Which BJT configuration is most commonly used for the below mentioned applications?
(i) Impedance Matching
(ii) Amplification [2] [CO2]

(b) The constant-current region of a JFET lies between .....
i) cut off and saturation
ii) cut off and pinch off
iii) 0 and I_{DSS}
iv) pinch-off and breakdown [2] [CO2]

(c) If A_{DM} =3500 and A_{CM} = 0.35, the CMRR is .....
(i) 1225 (ii) 10,000 (iii) 80 dB
(iv) answer (ii) and (iii) [2] [CO3]

(d) Write the excitation table of a RS Flip Flop. [2] [CO4]

(e) Three T flip flop are connected to form a counter. How many maximum no of states and the maximum count is possible? Also explain the results.
(i) 5 (ii) 3 (iii) 8 (iv) 7 [2] [CO5]

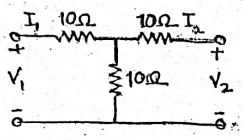
Q2. (a) In a P-type germanium, $n_i = 2.1 \times 10^{19}$ m^{-3}, density of boron is 4.5×10^{23} atoms /m^3. The electron and hole mobility are 0.4 and 0.2 $m^2 v^{-1} s^{-1}$ respectively. What is its conductivity before and after addition of boron atoms? [3] [CO1]

(b) A bar of silicon at room temperature with a cross-sectional area A = 10^{-4} cm^2 is known to contain a (uniform) hole concentration of p = 4.5. 10^{15} cm^{-3}. In an applied electric field F = 1.5kV/cm, the measured current is 45 mA.
(i) determine the average drift velocity of holes;
(ii) calculate the hole diffusion coefficient. [5] [CO1]

(c) Graphically explain the IV-characteristics for a zener breakdown and an avalanche breakdown. [2] [CO2]

Q3.(a)Calculate the value of feedback resistor (Rs) required to self-bias JFET with I_{DSS}=40mA, V_P=-10V and V_{GSQ}= -5V. [3] [CO2]

(b) Find the h-parameters of the circuit shown in the below figure:

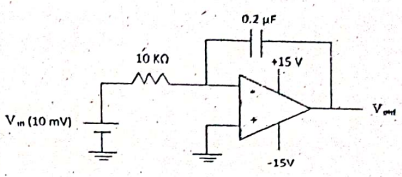


[5][CO2]

(c) The dc current gain of a transistor in CE configuration is 100. Find its dc current gain in CB configuration? [2][CO2]

Q4. (b) Assume Silicon (bandgap 1.12 eV) at room temperature (300 K) with the Fermi level located exactly in the middle of the bandgap. Answer the following questions:
(i) What is the probability that a state located at the bottom of the conduction band is filled?
(ii) What is the probability that a state located at the top of the valence band is empty? [5] [CO1]

(b) Explain the working of OP-AMP as an integrator and derive the expression for the output voltage (V_0) for a given input voltage (V_I). For the circuit given below, how long does it take for the output to reach saturation voltage and also draw the output? [5] [CO3]



Q5. (a) How many different types of register are there? Explain the working of a storage register. [5] [CO4]

(b) Design a shift register circuit which could be built from D-type flip-flops with the ability to shift data either to the right or to the left, on command. Explain the working by using schematic and clock diagram. [5] [CO5]

Q6. (a) Convert JK to D flip flop and draw the final circuit diagram. [5] [CO5]

(b) Draw and explain the logic diagram, truth table and clock diagram for a 4-bit Ring counter. [5] [CO4]

++ 213

Total Number of Page 2
3rd SEMESTER
END SEMESTER EXAMINATION

Roll. No.....
M.Sc. (PHYSICS)
Nov/Dec-2022

MSPH201: Atomic and Molecular Physics

Time: 03:00 Hours *Max. Marks: 50*

Note: Answer All questions. Assume suitable missing data if any.

Part A (Atomic Physics)

Q1.

(a) What is Zeeman Effect? How it can be understood on quantum mechanical basis? Obtain an expression for Zeeman splitting of atomic energy levels in a magnetic field B. Explain the magnetic splitting of sodium D-lines. [5][CO#2]

(b) What is spin-orbit interaction? Calculate the energy shift due to spin-orbit interaction term in H-like system. Discuss the significance of this shift in relation to the fine structure of hydrogen spectral lines. [5][CO#1]

(c) Compute the field gradient of a 0.5 m long Stern- Gerlach magnet that would produce a 1 mm separation at the end of the magnet between the two components of a beam of silver atoms emitted from an oven at 960 °C. The magnetic dipole moment of silver is due to a single $l = 0$ electron, just as for hydrogen. (Boltzmann constant $k = 1.38 \times 10^{-23}$ K). [5][CO#2]

Q2. State Bohr's postulates and deduce an expression for the allowed energies of the hydrogen atom. Show an energy level diagram for the observed transitions. What are the limitations of Bohr's theory? [5][CO#1]

OR

Derive an expression for Larmor precessional frequency. What is its importance? A beam of electrons enters a uniform magnetic field of flux density 1.2 Tesla. Calculate the energy difference between electrons whose spins are parallel and antiparallel to the field. [5][CO#2]

Q3. Write Short Notes on any **Two** of the following

(a) Vector-atom model [2.5][CO#1]

(b) Lamb Shift [2.5][CO#1]

(c) Stark effect [2.5][CO#2,3]

214

12

Part B (Molecular Physics)

Q4. Attempt any Five of the following. All parts carry equal marks. [15][CO#3,4,5]

(a) Explain Kasha's rule with a suitable schematic diagram.
(b) Discuss Predissociation.
(c) Discuss Fortrat diagram.
(d) In CO the J =0 $\rightarrow$J=1 absorption line occurs at a frequency of 1.15×10^{11} Hz. What is the bond length of CO molecule?
(e) Discuss all the factors affecting the intensities of rotational spectral lines, including the role of isotopic substitution.
(f) The force constant of the bond in CO molecule is 1870 N m^{-1}. Calculate the frequency of vibration of the molecule and the spacing between its vibrational energy levels in eV. Given that the reduced mass of CO=1.14×10^{-26} kg, h=6.63×10^{-34} J s and 1eV=1.6×10^{-19} J.
(g) If the fundamental band of H^1Cl^{35} lies at 3.46 μm (micron), calculate the wavelength of the corresponding band of H^2Cl^{37}.

Q5. Answer the following:

(a) The carbon monoxide (CO) molecule has a bond length R of 0.113 nm and masses of the ^{12}C and ^{16}O atoms are 1.99×10^{-26} kg and 2.66×10^{-26} kg respectively. Find (i) the energy and (ii) the angular velocity of the CO molecule when it is in its lowest rotational state. [5][CO#5]
(b) Derive energy/frequency expression of a diatomic vibrating rotator considering the concept of Born-Oppenheimer approximation and obtain the transitions between the rotational-vibrational energy levels, i.e., the vibration-rotation spectrum. [5][CO#5]

13

215

Total Number of Page: 02

Roll. No.....

III SEMESTER
M.Sc. (PHYSICS)

END SEMESTER EXAMINATION

Nov/Dec-2022

MSPH203: Nuclear and Particle Physics

Time: 3 Hours

Max. Marks: 50

Note: Answer All questions.
Assume suitable missing data, if any

Q1. Explain the fundamental characteristics of Nuclear Forces? Which of the nuclear phenomenon happens due to disintegration of the atomic nucleus? Determine the minimum energy (in MeV) needed to remove just one proton from the nucleus C. (Let the mass of a proton be 1.0078 u, the mass of C be 12.0000 u, and the mass of B be 11.0093 u.) 5 [CO:1,2]

Q2. i) Explain the importance of the use of beam of particles (Electrons or protons) in the field of nuclear physics? Use energy methods to calculate the distance of the closest approach for a head-on collision between an alpha particle with an initial energy of 0.5 MeV and a gold nucleus (^{197}Au) at rest. 5 [CO:2]

ii) Explain the term: Binding energy per nucleon in view of the stability of nuclei. Give an example of a compound which has a doubly magic number nucleus? Explain semi-empirical mass formula with significance of various terms in terms of their gravity. 5 [CO:1,2]

216

Q3. Starting from assumptions, mention various achievements and failure of shell model and its implications for the heavier and lighter nuclei an its structure with examples? 5 [CO:2

Q4. Explain the following: 20 [CO:1, 2,

Nuclear Scattering Processes, Controlled thermonuclear Reaction Nuclear Spin and Nuclear decay, Nuclear Magnetic Dipole mome Environmental effects of Nuclear Power, Different types of Nucle Reactions, Main Components of Nuclear Reactor and its working, Ro of particle physics in astronomy

Q 5. i) Explain the difference among alpha, beta and gamma decay with examples? If radiation is dangerous then why do we use it? Why do Nuclear Reactions Release Tremendous Amounts of Energy? 5 [CO:3,

ii) Does fusion produce radioactive waste the same way as fission does? Explain? Illustrate the difference between fusion and fission reactions? Can fusion cause a nuclear accident? Justify with examples? 5 [CO:3, 4]

Total No. of Pages: 3 *Roll No. .....*

THIRD SEMESTER M.Sc.(Physics)

END SEMESTER EXAMINATION *(Nov.-2022)*

MSPH207 – FIBER AND INTEGRATED OPTICS

Time: 3 Hours *Max. Marks: 50*

1. Answer any five

(a) The values of the propagation constant β of TM_m modes are smaller than those of the corresponding TE_m modes. Explain.

(b) Write the transcendental equations for the symmetric and asymmetric TE modes of a symmetric planar step index waveguide at cut off.

(c) Briefly indicate with the aid of suitable diagrams the difference between the meridional and skew ray paths in step index fibers.

(d) Sketch a diagram for normalised frequency vs normalised propagation constant for fundamental and first higher order propagating mode in case of step index optical fiber.

(e) Calculate the pulse broadening per unit length of the fiber having core diameter = 100μm, core refractive index = 1.5 and cladding refractive index = 1.48.

(f) Illustrate the following conditions in an optical fiber

(i) Angle of incidence is less than the critical angle of incidence

(ii) Angle of incidence is equal to the critical angle of incidence

(iii) Angle of incidence is greater than the critical angle of incidence

[2*5 =10 marks] [CO:1,2]

2. Plot normalized radial intensity distribution of LP_{01} , LP_{12} and LP_{21} modes for a step index fiber.

[3 marks] [CO:1]

3. Briefly explain the techniques which are adopted to obtain line width narrowing in semiconductor laser diodes.

[3 marks] [CO:3]

4. Explain the Plasma – Activated Chemical Vapor deposition method for the fabrication of optical fibers.

[3 marks] [CO:4]

5. Consider a 30 Km long optical fiber that has an attenuation of 0.4dB/Km at 1310 nm. Find the optical output power Pout if 200μW of optical power is launched into the fiber.

[3 marks] [CO:2]

6. Consider an LED operating at 1.3μm with a spectral width of 20 nm. At this wavelength $\frac{d^2n}{d\lambda_0^2} \approx -0.00055\ \mu m^{-2}$. Calculate the material dispersion.

[3 marks] [CO:2]

7. Starting from the Maxwell's Equations for dielectric medium, establish an eigen value equation for step index optical fiber. Point out the method to solve the above mentioned Eigen value equation.

OR

Using boundary Conditions for a TE mode derive the eigenvalue equation for a planar symmetric step index waveguide. Discuss the graphical method to find its solution.

[5 marks] [CO:1,4,5]

8. Calculate the power associated with the symmetric TE mode in a planar step index waveguide.

[5 marks] [CO:1,4,5]

9. (a) Obtain the expression for waveguide dispersion in optical fibers.

[3 marks] [CO:2,4]

(b) An approximation for the normalised propagation constant in single mode step index fiber is given by

$$b(V) \approx \left(1.1428 - \frac{0.9960}{V}\right)^2$$

Obtain the corresponding approximation for the waveguide parameter $V\frac{d^2(bV)}{dV^2}$ and hence write down the expression for waveguide dispersion in the fiber.

[2 marks] [CO:2,4]

10. A double heterojunction LED emiting at peak wavelength of 870 nm has radiative and non radiative recombination times of 60 ns and 100 ns respectively.
Determine the total carrier recombination life time and the power internally generated within the device at a drive current of 40 mA.
If the refractive index of the light source material is n = 3.5. Find the power emitted from the device.

[3 marks] [CO:3]

(b) With the help of suitable diagram, explain the frequency response for an LED, exhibiting electrical bandwidth and optical bandwidth. Mention the relationship between optical bandwidth and output power.

[2 marks] [CO:3]

11. What is threshold gain? Obtain expression for threshold gain in a laser diode.

[5 marks] [CO:3]

Total no. of Pages 02 *Roll no.....*

Third Semester
M.Sc. (Physics)

END TERM EXAMINATION November 2022

MSPH 215 Plasma Physics

Time : 3:00 Hours Max. Marks : 50

Note : Attempt all the Questions.
All Questions carry equal Marks
Assume Suitable missing date, if any

Q.1. Explain the construction and working of Q-Machine in a dusty plasma. How can you measure the plasma parameters (electron density and temperature) using Langmuir probe techniques? [10][CO#1]

Or

What is the magnetic moment in plasma? Show that for a diamagnetic case the magnetic moment is given by $\vec{\mu} = -\frac{W_\perp}{B^2}\vec{B}$, where $W_\perp$ is the transverse kinetic energy of the particle. [10] [CO#1]

Q.2. What are the electrostatic ion –cyclotron waves? An ion beam of density n_{ob}, velocity $\overrightarrow{v_{ob}} \| \hat{z}$, charge (+e) and mass m_b is propagating through a plasma of electron density n_{oe}, electron temperature T_e, ion density n_{i0}, ion mass m_i, ion temperature $T_i \approx 0$ immersed in a static magnetic field $\overrightarrow{B_0} \| \hat{z}$. Show that the growth rate of the unstable mode is given by

$$\gamma = \left(\frac{\omega_{pb}^2 \alpha_1}{2}\right)^{1/3}, \alpha_1 = \frac{kc_s}{\left(1+\frac{k^2c^2}{\omega_{pi}^2}\right)^{1/2}}$$ [10] [CO#2]

Or

Show that the dispersion relation for electrostatic waves in a magnetized plasma is given by

$$\varepsilon \equiv 1 - \frac{\omega_p^2}{\omega^2}\frac{k_z^2}{k^2} - \frac{\omega_p^2}{\omega^2-\omega_c^2}\frac{k_x^2}{k^2} - \frac{\omega_{pi}^2}{\omega^2}\frac{k_z^2}{k^2} - \frac{\omega_{pi}^2}{\omega^2-\omega_i^2}\frac{k_x^2}{k^2} = 0$$

[10] [CO#2]

220

18

Q. 3. What is kelvin Helmholtz Instabilities (KHI)? For a fully ionized plasma in the presence of magnetic field, show that the instability occurs if

$$A > \frac{\gamma}{\beta}\left[1+\frac{1}{2}\frac{\Lambda^2}{(\gamma/\beta)^2}\right].$$

[10] [CO#3]

Q.4. What is the distribution function f? Solve the Vlasov equation for an isotropic plasma (B_s =0) and obtain $\varepsilon = 1+\chi_e+\chi_i$, where

[10] [CO#4]

$$\chi_e = \frac{2\omega_{pe}^2}{k^2 v_{th}^2}\left[1+\frac{\omega}{kv_{th}}Z\left(\omega/kv_{th}\right)\right] \quad \text{and} \quad \chi_e = \frac{2\omega_{pi}^2}{k^2 v_{thi}^2}\left[1+\frac{\omega}{kv_{thi}}Z\left(\omega/kv_{thi}\right)\right]$$

Q.5. What is Free Electron Laser (FEL)? Explain the physical mechanism using schematic diagram. Show that the growth rate of the FEL instability is given by

$$\Gamma = \left(\frac{v_{o\perp}^2}{c^2}\frac{\omega_{pb}^2 k_{\parallel} c}{\gamma_0^3}\right)^{1/3}\frac{\sqrt{3}}{2}.$$

[10] [CO#5]

Or

What is Cerenkov free electron laser (CFEL)? Explain the physical mechanism using suitable schematic diagram. [10] [CO#5]

Total No. of Pages: 2

Roll No. .....

THIRD SEMESTER

M.SC. [PHYSICS]

END SEMESTER EXAMINATION

(November, 2022)

MSPH-217 **CHARACTERIZATION TECHNIQUES**

Time: 3:00 Hours

Max. Marks: 50

Note: Answer Any **FIVE** questions. **Question No. 1** is Compulsory. Assume suitable missing data, if any

1. Answer all the questions. **[2 x 5]**

[a]. Explain Bragg's law? Derive the Bragg's formula: $2d\sin\theta = n\lambda$. (CO1)

[b]. Determine the frequency and energy of CuKα ($\lambda = 0.15418\ nm$) and FeKα ($\lambda = 0.19373\ nm$). (CO1)

[c]. Briefly, explain energy dispersive X- rays (EDX) spectroscopy. How EDX is beneficial for characterization of materials? (CO2)

[d]. Draw SEAD patterns of single crystalline, polycrystalline and amorphous solids by TEM/ HR-TEM. (CO4)

[e]. What is the difference between IR and FTIR? Why KBr material is used as binder for sample preparation in FTIR? (CO3)

2[a]. Define 'multiplicity' and 'structure factor'. Assuming proper fractional atomic positions of 'body centered cubic' cell, find out the structure factor in mixed and unmixed state of intensity. (CO1) **[5]**

[b]. Explain the basic principle and instrumentation of X-ray Photo Electron Spectroscopy. Write the different characteristics studied/ analyzed by XPS. (CO3)**[5]**

3[a]. Discuss working and principle of FTIR. Consider a FTIR pattern of any compound and show finger print and characteristic regions in it and explain. Write the wavenumbers of C-O, C-C and C=O stretches. (CO3) **[7]**

[b]. A microscope consists of a 5X objective and a 20X ocular. The distance between the lenses is 15 cm. (a) Determine the overall magnification if the eye is relaxed (b) determine the focal length of the ocular lens (c) the focal length of the objective lens. (CO4) **[3]**

4[a]. Discuss about secondary electron (SE), backscattered electron (BSE) and X-rays ejection and their applications in material characterization for a scanning electron microscope (SEM). Distinguish between SEM and FE-SEM. (CO4) **[7]**

[b]. An electron beam of brightness, $10^{10}\ Am^{-2}sr^{-1}$ is focused to a spot of diameter 100 nm at the specimen. What is the current density within the spot and what is the dose rate in electrons per square nm per second? Take the convergence angle to be 0.04 radians. (CO2) **[3]**

5[a]. Discuss about contact and non contact mode of Atomic force microscope (AFM). Using force – distance curve, explain the cantilever and tip interaction with the specimen to measure adhesion force using AFM. (CO4) **[7]**

[b]. Define Peizo sensitivity in AFM, if a cantilever travels a distance of 40 nm during adhesion force measurement for a deflection of 5 V signal, calculate the sensitivity of Peizo crystal. (CO2) **[3]**

6[a]. Explain the principle, working and application of thermal gravimetric technique (TGA). Write any example for multiple transition with weight losses and signify the transition process. (CO5) **[7]**

[b]. A mixture of $CaCO_3$ and CaO is analyzed using TGA technique. TGA curve of the sample indicates that there is a mass change from 145.3 mg to 115.4 mg between 500–900 °C. Calculate the percentage of $CaCO_3$ in the sample. (CO5) **[3]**

7. Discuss briefly any ***FOUR***. **[5X4]**

[a]. Magnetic force microscopy (MFM) (CO4)

[b]. Deep level transient spectroscopy (DLTS) (CO3)

[c]. Bright field optical microscopy (BFOM) (CO4)

[d]. Differential thermal analysis (DTA) (CO5)

[e]. Atomic absorption spectroscopy (AAS) (CO3)

[f]. Differential scanning calorimetry (DSC) (CO5)

Total No. of Printed Pages: 2

Roll No..... 222

END SEMESTER EXAMINATION

MSc Chemistry

FIRST SEMESTER

September 2022

MSCH 101 Inorganic Chemistry

[Time: 3 Hours]

[Max. Marks: 50]

Instructions: All Questions are compulsory
Neat diagrams must be drawn wherever necessary.
Assume missing data if any.

Part A (Chemical Bonding and Stability constants)

Q1a) Discuss the structure of following molecules using VSEPR theory

i) PF_5
ii) SF_4,
iii) ClF_3
iv) $[ICl_2]^-$
v) $[PbF_6]^{2-}$

b) Using VSEPR approach differentiate between the hybridization, molecular shape, and variation in bond angles of BF_3 and $N(SiH_3)_3$ CO1 (5 marks)

Q2a) Predict the shape of an H_2O molecule on the basis of a Walsh Diagram for an AB_2 molecule. CO1

b) Calculate the overall stability constant for a $[Cu(NH_3)_4]^{2+}$, given that stepwise stability constant for this complex are log K_1= 4.0, log K_2 = 3.2, log K_3 = 2.7, log K_4 = 2. Write down the chemical equation involved (including stepwise) during the formation of above complex. CO2 (5 marks)

Q3 a) Define titration error. What is the information that can be obtained from a titration curve in complexometric titration.

b) Calculate the value of pM_{eq} in a titration of metal ion concentration 10^{-15} M with EDTA at pH= 10 using EBT as indicator having $\log K_{M\text{-}EDTA}$ of 19.4. CO3 (5 marks)

Q4 Define formation constant. How one can determine the formation constant using pH metry and jobs method. CO2 (5 marks)

223

Q5 Define $\bar{n}$, φ and α. Derive a relation showing that n, φ and α. are independent of total concentration of ligand. CO2 (5 marks)

Part B: Supramolecular Chemistry

Q6 The rate of electron transfer involving $[Ru(bpy)_3]^{2+/3+}$ pair is greater than that involving $[Ru(NH_3)]^{2+/3+}$. Explain. CO4 (5 marks)

Q7 Draw and explain the molecular orbital diagram of $[Ru(bpy)_3]^{2+}$. Explain the possible electronic transitions. CO4 (5 marks)

Q8 Select an appropriate ligand "L" in the complex $[(NH_3)_5Ru^{II}\text{-}L\text{-}Ru^{III}(NH_3)_5]$ and explain the three (I, II and III) mixed valence behaviour. CO5 (5 marks)

Q9 What are the possible conformations for Calix[4]arene ? Mention the relevant types of interactions that are responsible for the dual binding of cations and neutral molecules in the p-tert-butyl Calix[4]arene. CO5 (5 marks)

Q10 What are the special features of $[Ru(bpy)_3]^{2+}$ that makes this complex a successful photosensitizer? Mention also the limitations of this complex? CO6 (5 ma

224

Total No. of Pages 2 | Roll No. .....

FIRST SEMESTER | M.Sc. (Chem.)

END SEMESTER EXAMINATION | *Nov-2022*

MSCH – 103 (Organic Chemistry – 1)

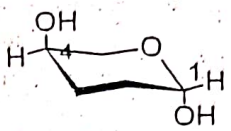
Time: 3 Hours | *Max. Marks: 50*

Note: Answer questions of courses A and B separately in single answer sheet. Assume suitable missing data, if any.

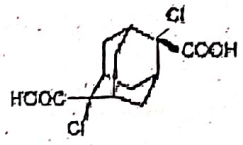
Course A: Stereochemistry

[1] CO1&2

a) Assign correct chirality to the following molecules [I, II] [2]



I



II

b) Predict the most stable conformer of butane-2,3-diol with proper justification. [1]

c) Explain Enantiotopic and diastereotopic faces with suitable examples. [2]

[2] Comment on any **four** CO1&2 [2×4=8]

a. Racemic Mixture and Racemic solid solution

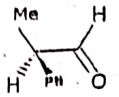
b. Stereochemistry of Ansa compounds

c. Lowe's Rule

d. Chiral Lanthanide Shift Reagent

e. Enantiomeric Amplification

[3] State Cram's rule. Predict the predominant diastereomer formed in the following asymmetric induction. Explain the mechanism. CO2[2,1,2]



CH_3MgBr Major Product + Minor Product

[4] A solution of (+) alanine from a fossil displays a specific rotation; $[\alpha]$= 4.25. If the specific rotation of pure (+) alanine is 8.50, Calculate CO2[2]

(i) the optical purity of the sample and

(ii) find the amount of (+) and (-) form of alanine in the sample

[5] Discuss the stereochemical aspect of cyclohexene CO1[2]

[6] Illustrate the following chiroptical properties CO2[3]

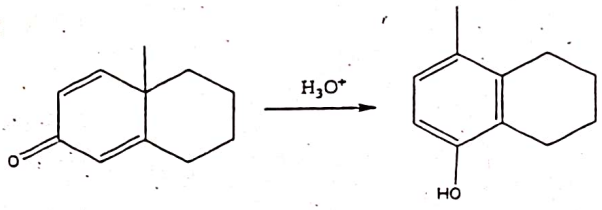
(a) Circular birefringence and (b) Circular dichroism.

Course B: Reaction intermediates & Mechanism

(Answer any **five** questions)

[7] Write the reaction and mechanism of Lossen rearrangement. CO4[5]

[8] Give mechanism for the given reaction: CO3&4[5]



[9] What is Claisen-Schmidt reaction? Give mechanism. CO3&4[5]

[10] Comment on the reaction of benzene and phenol each with chloroform and sodium hydroxide. Provide mechanism if any. CO3&4[5]

[11] Discuss the regioselectivity in radical halogenation with example. CO4[5]

[12] Give a method each for the generation of carbocation, carbanion, carbene, radical and nitrene. CO3[5]

~~24~~

226

Total No. of Pages:02 *Roll No. ... .*

First Semester

M.Sc.

END TERM EXAMINATION *Nov/Dec-2022*

MSCH 105 Physical Chemistry-I

Time: 3 Hours *Max. Marks: 50*

Note: Attempt all Questions
All Questions carry equal marks.
Assume suitable missing data, if any.

Part-A

Q1. Describe the relationship between the current density and the electrode potential. [5 marks][CO2]

Q2. Illustrate Garrett-Brattain space charge. [5 marks][CO3]

Q3. Consider the dimerization A $\Leftrightarrow$A2 with forward rate constant k_a and backward rate constant k_b. Show that the relaxation time is: $\tau = 1/(k_b + 4k_a[A]_{eq})$. [5 marks][CO5]

Q4. Give an example for organic decomposition reaction and prove the order of the overall reaction is unity. [5 marks][CO4]

Q5. Explain flash photolysis or Oscillating reactions with an example. [5 marks][CO1]

Part-B

Q1. (a) Is the wavefunction $\psi(x) = (2/L)^{1/2} \sin(\pi x/L)$ of a particle in a box an eigenfunction of the operator d^2/dx^2 and, if so, what is the corresponding eigenvalue? [2martks] [CO3]
(b) State the postulates of quantum mechanics. [2 marks] [CO1]

227

Q2. A particle in an infinite one-dimensional box system was described by the wave function

$\psi(x) = N e^{x^2/2a}$. Normalize this function. [3 marks] [CO2]

Q3. (i) Using factorization method in the following equation, reduce it to $\left(\frac{d^2}{dy^2} - y^2\right)\psi = -\lambda\psi$

$$\frac{d^2\psi}{dx^2} + \frac{8\pi^2 m}{h^2}\left(E - \frac{1}{2}k_f x^2\right)\psi(x) = 0$$

[4 marks] [CO4]

Q4. What are ladder operators? Find out the commutator of $[a_+, a_-]$ for a linear harmonic oscillator. [1 + 3 marks] [CO1]

Q5. Applying step-up operator on ψ_2, find ψ_3 for a linear harmonic oscillator.

$\psi_2 = N_2 (4y^2 - 2) e^{y^2/2}$ [4 marks] [CO5]

Q6. Confirm that the wavefunction for a particle in a sphere may be written as $\psi(\theta, \varphi) = \Theta(\theta)\,\Phi(\varphi)$ by the method of separation of variables and find an equation for $\Theta(\theta)$. [4 marks] [CO4]

Q7. Deduce average value of $\langle r \rangle$ for ψ_{1s}.

$\psi_{1s} = 2\left(\frac{z}{a_o}\right)^{3/2} e^{-zr/a_o} \frac{1}{\sqrt{4\pi}}$ [2 marks] [CO3]

------End----

Total No. of pages: 03 Roll No.....

First SEMESTER

M.Sc. (Chemistry)

END TERM EXAMINATION *Nov-2022*

MSCH107 Elementary Topics for Chemists

Time: 3 hrs *Max. Marks: 50*

Course A: Mathematics for Chemists

Section-1 (7 marks)

Q-1 (a) Find the angle between two vectors $\vec{a}$ and $\vec{b}$, with magnitudes $\sqrt{3}$ and 2, respectively having $\vec{a} \cdot \vec{b} = \sqrt{6}$.

(b) Find the magnitude of $\vec{a} \times \vec{b}$ if $\vec{a} = (2, 1, 3)$ and $\vec{b} = (3, 5, -2)$.

[2][CO1]

Q-2 If $A = \begin{pmatrix} 3 & -2 \\ 4 & -2 \end{pmatrix}$ and $I = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$, find k so that $A^2 = kA - 2I$.

[2][CO1]

Q-3 Investigate the following system of equations for solution using matrix method.

[3][CO1]

$$x - y = 6$$
$$2x + y = 0$$

OR

Show that $|A| = \begin{vmatrix} 1 & 1 & 1 \\ a & b & c \\ a^2 & b^2 & c^2 \end{vmatrix} = (a-b)(b-c)(c-a)$

Section-2 (11 marks)

Q-4 (a) Find the derivative of the function $f(x) = 2x \sin(x^2)\,; x > 0$ with respect to x. [2+2+2=6][CO2]

(b) Identify a point of maxima/minima in $f(x) = (x+1)^2$.

(c) Evaluate $\int_0^1 x\, e^x\, dx$

228

Q-5 (a) Check whether the following differential equation is exact.

$$3x(xy-2)dx+(x^2+2y)dy=0$$

[2+3=5][CO2]

(b) Show that the given differential equation is homogeneous and then solve it.

$$(x-y)dy-(x+y)dx=0$$

Section-3 (7 marks)

Q-6 (a) A total of 52 % employees in a company are females, 15 % of total employees are managers and 30 % are either females or managers. What is the probability that an employee is female as well as a manager.

(b) Two balls are randomly drawn from a bowl containing 6 white and 5 black balls. What is the probability that one of the drawn balls is white and the other is black. [1+2=3][CO2]

Q-7 Find the median and mode of the following grouped data. [4][CO2]

Classes	0-10	10-20	20-30	30-40	40-50
Frequency	2	12	22	8	6

Course A: Biology for Chemists

Q1. What is a cell? What is the difference between prokaryotic and eukaryotic cells? Explain the different organelles present inside a eukaryotic cell. [5] [CO3]

Q2. What are biomolecules? Explain different types of biomolecules. [5] [CO3]

Q3. Write a short note on (any two): [5] [CO4]

1. Glycolysis
2. Krebs Cycle
3. Pentose Phosphate Pathway

Q4: What is a protein? Explain different levels protein structure. Describe biosynthesis of amino acids. What are hormones? [5] [CO4]

Q5: What are nucleic acids? Explain different types of nucleic acids. What are different forces that hold nucleic acid double helices together? [5] [CO3]

Course B: Standard Laboratory Practices and Chemical Safety

Attempt any **FIVE** questions from the following.

Q.1 Write SIX principles of green chemistry. Explain any one in detail. [5][CO5]

Q.2 List possible sources of fire in lab? Discuss any one in detail. [5][CO6]

Q.3 Define and classify Fire. Explain the difference between Fire and explosion. Explain different types of fire extinguishers. Suggest the conditions when you can use them and explain the PASS method. [5][CO6]

Q.4. Suggest and explain any three green experiments/ procedures that can be followed in the chemistry laboratory. [5][CO5]

Q.5. What do you mean by MSDS of a chemical? Explain. [5][CO5]

Q.6. Suggest the possible measures that can be taken in case of accidental contact of chemicals with skin and chemicals in the eyes. Write some of the adverse health impacts due to exposure of chemicals. [5][CO6]

Q.7. Draw and explain any five safety symbols that can commonly be found on the label of a chemical container. [5][CO6]

Total no. of Pages: 3

Roll no. 230

THIRD SEMESTER

M.Sc. (CHEM.)

END TERM EXAMINATION

Nov/Dec-2022

MSCH201 (Organic Chemistry – 3)

Time: 3 Hours

Max. Marks: 50

Note: Assume suitable missing data, if any.

[1] Answer any four of the following [3×4 = 12][CO1&2]

(a) Explain the catalytic cycle for the Stille Coupling and its application in organic synthesis.

(b) Explain Julia Peterson olefination with suitable example.

(c) Explain the Horner-Wadsworth-Emmos reaction with suitable example.

(d) Explain the reactivity of organocuprates and Grignard reagents on α, β unsaturated carbonyl compounds.

(e) Explain Ramberg-Backlund definitions.

[2] Answer the following [2×2 = 4][CO3]

(a) Distinguish between homogeneous and heterogenous hydrogenation.

(b) Write a short note on Corey-Chaykovsky reaction.

[3] Describe the methods of preparation and one important use of any three of the following reagents. [3×2 = 6][CO3&4]

(a) $(Ph_3P)_3RuClH$ (b) 9-BBN

(c) $NaBH_3CN$ (d) Disiamyl borane

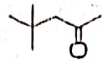
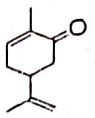
[4] Differentiate between Shapiro and Bamford Stevents Reactions. [4][CO1]

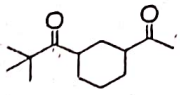
[5] Write the short note on any two of the following: [2×2 = 4][CO1-3]

(a) Sulphur Ylides (b) Birch Reduction (c) Wacker reaction

[6] List the products and outline the mechanism of any three of the following transformations: [4×3 =12][CO1-4]

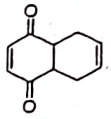
231

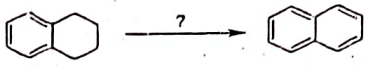
i)  $\xrightarrow[MeOH]{NaBH_4}$ ii)  $\xrightarrow[H_2,\ C_6H_6]{(PPh_3)_3RhCl}$

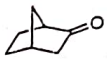
iii) $H_2C{=}\underset{H}{C}{-}CH_3$ $\xrightarrow[(ii)\ H_2O_2,\ NaOH]{i)\ BH_3\ (1\ equiv.)}$ iv)  $\xrightarrow[(1\ equiv.)]{Ph_3P{=}CH_2}$

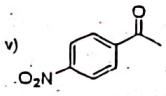
[7] Write the missing product(s) or reagents in any **eight** of the following reactions. [1×8 = 8][CO1-4]

i)  $\xrightarrow[ii)\ H_3O^+]{i)\ LiAlH_4}$

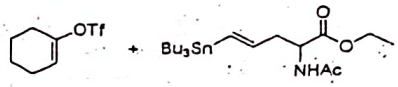
ii)  $\xrightarrow[ii)\ H_3O^+]{i)\ DIBAL\text{-}H}$

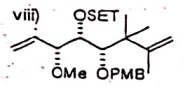
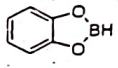
iii) 

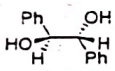
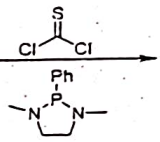
iv)  $\xrightarrow[Dioxane]{i)\ SeO_2,\ H_2O}$

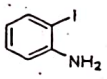
v)  $\xrightarrow[2\text{-Propanol}]{Al(O^iPr)_3}$

vi)  $\xrightarrow[ii)\ PCC]{i)\ MeLi}$

vii)  $\xrightarrow[AsPh_3,\ THF,\ Heat]{8\ mol\ \%\ Pd_2(dba)_3}$

viii)  +  $\xrightarrow[RT,\ H_2O_2,\ NaCH]{3\ mol\ \%\ Rh(PPh_3)_3Cl}$

ix)  $\xrightarrow[Ph]{Cl}$ 

x)  + $H{-}C{\equiv}C{-}SiMe_3$ $\xrightarrow[CuI,\ Et_2NH,\ 30\ °C]{Pd(PPh_3)_2Cl_2}$

30

232

Total No. of Pages:02 Roll No. .....

Third Semester
M.Sc.

END TERM EXAMINATION Nov/Dec-2022

MSCH 203 Physical Chemistry-III

Time: 3 Hours Max. Marks: 50

Note: Attempt all Questions
All Questions carry equal marks.
Assume suitable missing data, if any

Q1. Illustrate the interaction between spin and the magnetic field and derive the expression for separation between neighbouring energy levels. [5 marks] [CO1,CO3]

Q2. What are the selection rules for rotational and vibrational Raman spectroscopy? The anti-Stokes lines of the pure rotational Raman spectrum of a molecule are of roughly the same intensity as the Stokes lines, but the anti-Stokes lines of the vibrational Raman spectrum are generally much weaker than the Stokes lines. Account for this observation. [5 marks] [CO1,CO4]

Q3. What is Heisenberg uncertainty principle and apply for a particle in one dimensional box [5 marks] [CO1,CO5]

Q4. Deduce Einstein co-efficient for various emission processes [5 marks] [CO2]

Q5. Illustrate Stark Effect in detail [5 marks] [CO1]

Q6. Calculate the wavenumbers and wavelengths for pure rotational lines in the spectrum of HCl corresponding to the following changes in rotational quantum numbers $0 \rightarrow 1$, $1 \rightarrow 2$ and $8 \rightarrow 9$. The rotational constant of HCl is 10.5909 cm^{-1} [5 marks] [CO5]

Q7. The intensity of a transition is proportional, to a first approximation, to the population of the originating energy level. For a diatomic molecule treated as a rigid rotor, what is the population of the J^{th} level. (a) Sketch N_J against J and find the most populated J-level. (b) Find approximation for the rotational quantum number of the rotational energy level with the maximum population along with corresponding wavenumber and the rotational energy of most populated state. [5 marks] [CO5]

Q8. (a) Deduce the bond-stretching vibration frequency ν_{osc} of a diatomic molecule AB by classical method.

(b) Given that the stretching frequency of a C-C bond is approximately 1000 cm^{-1}, Calculate the stretching frequencies of C=C and C≡C bonds on the assumption that double and triple bonds have force constants which are, respectively, two or three times those of a single bond. [10 marks] [CO3][CO5]

Q9. Explain why the overtone of a particular vibrational band of an anharmonic oscillator will not be found at exactly 2, 3, 4, ... times the frequency of the fundamental. [5 marks] [CO3]

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52

234

Total No. of Pages: 2
End SEMESTER EXAMINATION
THIRD SEMESTER

Roll No.....
Chemistry
November 2022

MSCH 205 Inorganic Chemistry-3

[Time: 3 Hours] [Max. Marks: 50]

Instructions: *Attempt any 10 questions*
Neat diagrams must be drawn wherever necessary.
Assume missing data if any.
All question carries equal marks.

Q1. Following the 18 electron rule, determine *x* in the following complexes. [CO1]

(i) $[\eta^5\text{-Cp Os(CO)}_x]_2$

(ii) $[Co(CO)_3]^x$

(iii) $[\eta^5\text{-Cp Fe(CO)}_3]^x$

(iv) $[Ni(CO)_3(NO)]^x$ (NO as linear)

(v) $[\eta^6\text{-}(C_6H_6)Mn(CO)_2(CH_3)]^x$

Q2. Suggest a sequence of reactants for the selective preparation of *cis*-$Fe(PPh_3)_2(CO)_3$. You're given Fe metal, Co, PPh_3. Use any reagent of your choice. [CO2]

Q3. The rhenium complex $Re(Cl)(N_2)(PMe_2Ph)_4$ upon heating loses a colourless gas and form a new complex. The new complex obeys the 18-ē rule, does not possess M−M bond, and its ^{31}P NMR chemical shift are comparable to that of the parent compound. Suggest the possible structure. [CO2]

Q4. The substitution of CO by seven different phosphine ligands in $V(CO)_6$ shows that the basicity/ nucleophilicity of the phosphine affects the rate of the reaction. It is also observed that the rate is unaffected by the concentration of CO. for PPh3, $\Delta S^{\ddagger} = -28$ e.u. Comment on the mechanism of the reaction: [CO3]

$$V(CO)_6 + PR_3 \xrightarrow[\text{Hexane}]{25^\circ C} V(CO)_5PR_3$$

235

Q5. The compound $Co_3CH(CO)_9$ is formed from the reaction of chloroform with $Co_2(CO)_8$. The IR spectra shows the presence of terminal carbonyl only and the presence of CH is confirmed by ^{1}H-NMR. Prepare the reaction based on Wade's rule. [CO2]

Q6. CH_2=CHR on hydroformylation forms RCH_2CH_2CHO. The reaction occurs at 120°C and the catalyst used is $Co_2(CO)_8$. However, when the temperature is raised to 185°C $RCH_2CH_2CH_2OH$ is formed as a major product from the competing reaction. Write down the steps involved in the reduction of aldehyde to the alcohol. [CO3]

Q7. Discuss the advantages of Cativa process over Monsanto process for the production of acetic acid. [CO3]

Q8. Warker process is used for the synthesis of aldehyde and ketones from the alkene using a palladium catalyst in aqueous medium. How would you prepare acetone from 1-propene? Write the suitable mechanism. [CO3]

Q9. Which of the following compound are likely to act as a promoter in the Cativa process? Justify your answer for: [CO4]

GaI_3, $[Ru(CO)_3I_3]^-$, $[Ru(CO)_2I_4]^{2-}$, ZnI_2, LiI, SiI_4

Q10. What will be the expected product from the Warker process if the reaction is carried out in (a) methanol medium, and (b) hydrocarbon medium? [CO3]

Q11. When a freshly sublimed $Me_3NO.2H_2O$ is reacted with $Fe(CO)_5$, a Me_3N substituted iron carbonyl is formed along with CO_2. Show how the products are formed. [CO4]

$$Fe(CO)_5 + Me_3NO.2H_2O \xrightarrow[-30^\circ C]{THF} Fe(CO)_4(Me_3NH_4) + CO_2 + 2H_2O$$

Q12. Write the product A, B and C in the following reaction: [CO5]

$$\underset{cis}{Pt(Et_3P)_2(CH_2CMe_3)_2} \xrightarrow[-L]{x} A \xrightarrow[+L]{R.E.} B + C$$

x = cyclometallation
R.E.= reductive elimination

Total No. of Printed Pages: 2 Roll No.....

END SEMESTER EXAMINATION MSc Chemistry

THIRD SEMESTER November 2022

MSCH 207b Inorganic Reaction Mechanism and Bioinorganic Chemistry

[Time: 3 Hours] [Max. Marks: 50]

Instructions: All Questions are compulsory
Neat diagrams must be drawn wherever necessary.
Assume missing data if any.

PART A

Q1 Discuss and explain electron transfer reaction in the following reaction
$[Co(NH_3)_5Cl]^{2+} + [Cr(H_2O)_6I]^{2+} \rightarrow [Co(NH_3)_5H_2O]^{2+} + [Cr(H_2O)_5Cl]^{2+}$
CO3 (5 marks)

Q2 What are substitution reactions? Discuss SN1 and SN2 mechanism for octahedral complexes. Enlist the factors that affect rate of substitution in octahedral complexes.
CO1 (5 marks)

Q3 Propose an efficient route for the synthesis of cis and trans isomer of $[Pt(NH_3)_2Cl_2]$ using square planar $[Pt(Cl)_4]^{2-}$/ $[Pt(NH_3)_4]^{2-}$ as starting material
CO2 (5 marks)

PART B

Q4 Explain in detail the structure and function of Hb & Mb. Also mention changes that occur in heme group of haemoglobin on going from deoxy to oxy form.
CO4 (5 marks)

Q5 Classify the elements based on their action in biological system. Give suitable example for each. Which metals typically bind in chlorophyll, corrin, and protoporphyrin IX in biologal system?

CO4 (5 marks)

Q6 Distinguish between natural and synthetic oxygen carrier using suitable examples. Explain the role of Vaskas complex as an oxygen carrier? CO4 (5 marks)

Q7 Discuss the mechanism of action of platinum complexes in cancer treatment. Why is cisplatin used by oncologist in preference to the trans-isomer. CO6 (5 marks)

Q8 What are iron sulfur proteins? Explain in detail the role of Fe-S proteins in biological system with emphasis on structural features. CO4 (5 marks)

Q9 Explain the mechanism of biological nitrogen fixation in detail. Highlight the role of Mo cofactor in nitrogen fixation. CO4 (5 marks)

Q10 What is meant by active transport in Na^+ -K^+ pump? Give a diagrammatic representation of the process and explain the mechanism involved in it. CO5 (5 marks)

239

Total No. of Pages 1

THIRD SEMESTER

Roll No. .....

M.Sc. [Chem]

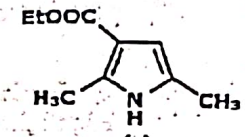
END SEMESTER EXAMINATION *Nov/Dec-2022*

MSCH – 207c (Organic Synthesis and Heterocyclic Chemistry)

Time: 3 Hours *Max. Marks: 50*

Note: Assume suitable missing data, if any.

[1] Discuss the retrosynthetic analysis and synthesis of **any four** molecules: [5×4 = 20] [CO1&2]



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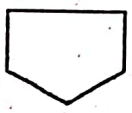
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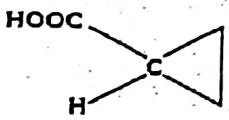

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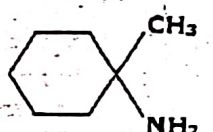

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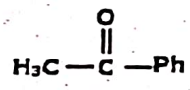


(e)

[2] How will you synthesize azepine from nitrobenzene? Discuss the mechanism. [4][CO3&4]

[3] Write the product(s) for the reaction of quinoline or isoquinoline (**do any one with a-c**) with (a) HNO_3/H_2SO_4, (b) $Br_2/AlCl_3$, and (c) H_2, Pt, 12 N HCl. [3][CO4]

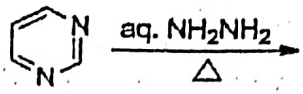
[4] Write the 'Paal-Knorr' synthesis for furan and pyrrole with mechanism involved. [5][CO3]

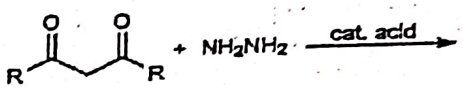
[5] Give any one synthetic method with mechanism for azetidine and oxetane. [5][CO3]

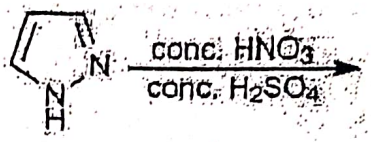
[6] Write short note on the importance of heterocyclic compounds. [3][CO3]

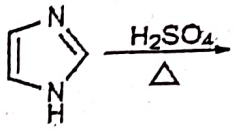
239

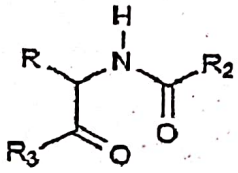
[7] Complete the reaction (**any ten**) [10×1=10][CO3&4]

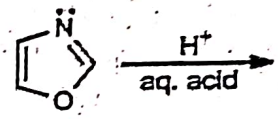
(i) 

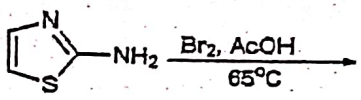
(ii) 

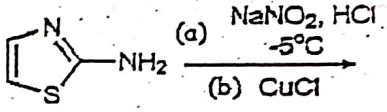
(iii) 

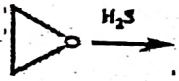
(iv) 

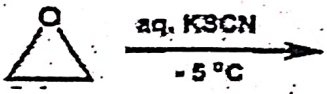
(v) 

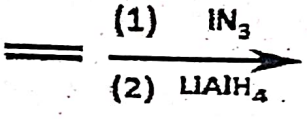
(vi) 

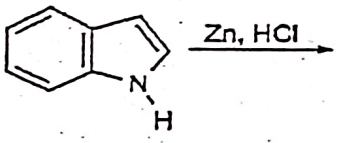
(vii) 

(viii) 

(ix) 

(x) 

(xi) 

(xii) 

240

Total No. of Pages 1 | Roll No. .....

THIRD SEMESTER | M.Sc. Chem.

END SEMESTER EXAMINATION | Nov/Dec-2022

MSCH-207d Solid State Chemistry

Time: 3:00 Hours | Max. Marks: 50

Note : Answer any five questions. All questions carry equal marks. Assume suitable missing data, if any.

[1] (i) Describe Czochralski method for crystal growth. 3[CO1]

(ii) Define non-molecular solids. 1½[CO3]

(iii) What do you mean by superconductor? Explain it. 1½[CO3]

(iv) What is the relation between electron affinity, ionization potential and band gap? Explain with the help of energy band diagram. 4[CO3]

[2] (i) Explain the X-ray emission spectrum of copper. 3[CO2]

(ii) How are synchrotron radiations advantageous over conventional X-ray sources? 2[CO2]

(iii) Distinguish between conductor and insulator with the help of band theory. 3[CO3]

(iv) Semiconductors are the building blocks of the modern technology. Justify it. 2[CO3]

[3] (i) Derive Bragg's equation. 3[CO2]

(ii) When a crystal was studied by the Bragg's technique using X-rays of wavelength 229 pm, and X-ray reflection was observed at an angle of 23°20'. 2[CO2]

(a) What will be the corresponding interplanar spacing?

(b) When another X-ray source was used, a reflection was observed at 15°26'. What was the wavelength of these X-rays?

(iii) Describe Meissner effect. 2[CO3]

(iv) Explain the conduction mechanism in the semiconductors. 3[CO3]

[4] (i) Draw and briefly explain the phase diagram of eutectoid reaction in the system Na_2O-SiO_2. 3+3[CO3]

(ii) Explain the types of semiconductors known to you. 2[CO3]

(iii) Discuss about the ferromagnetic domains. 2[CO4]

[5] (i) List out all the practical considerations that must be taken into account for a solid-state reaction. 3[CO1]

(ii) What are the limitations of powder XRD method? 3[CO2]

(iii) Elaborate the classification of magnetic materials in detail. 4[CO4]

[6] (i) Is there any difference between ferrites and ferromagnetic materials? Explain with suitable examples. 3[CO4]

(ii) Discuss the phase diagram of eutectoid reaction in the Fe-C system. 4[CO3]

(iii) Write a short note on Curie and Curie-Weiss law. 3[CO4]

[7] Write a short note on the following. 2½x4[CO1-4]

(i) Magnetic domains

(ii) Stockbarger method

(iii) Nucleation and growth

(iv) p-n junctions

40

242

Total No. of Pages: 01 Roll No:.....

FIRST SEMESTER M.Sc.

END SEMESTER EXAMINATION (Nov. 2022)

MSMA-101, Abstract Algebra

Time: 3 Hr. Max. Marks: 50

Note: Attempt Any Five questions.
All questions carry equal marks.

1. (a) Define a normalizer with an example. State and prove the necessary and sufficient condition for HK to be a subgroup of a group G, whenever H and K are subgroups of G.
(b) Define a cyclic group with an example. Show that there are $\phi(n)$ generators for a group of order n.

2. (a) Define a quotient group with an example. show that a subgroup N is normal in G iff $xN = Nx$ for all $x \in G$.
(b) State and prove 3rd fundamental theorem of group isomorphism.

3. (a) Let G be a finite group of order n and p, a prime divides n. Then show that G has an element of order p.
(b) State and prove Sylow's Second Theorem

4. (a) Define an integral domain with an example. Show that every finite integral domain is a Field..
(b) Define Maximal ideal with an example. Let R be a commutative ring with 1. Show that an ideal M is a maximal ideal iff $R=M$ is a Field.

5. (a) Define principal ideal domain with an example. Show that the ring $R = \{n/m | m,\ n \in \mathbb{Z},\ n \text{ odd}\}$ is a principal ideal domain.
(b) Define Euclidean domain with an example and show that every ideal of an Euclidean domain is principal ideal.

243

~~41~~

6. (a) *Define embedding. State and prove the embedding theorem.*
(b) *Define unique factorization domain with an example. If R is a UFD then show that an element in R is prime iff it is irreducible.*

~~A-2~~

244

Total No. of Pages: 02

Roll No:.....

First Semester

M. Sc.

End Term Examination

November, 2022

MSMA-103, Real Analysis

Time: 3 Hours

Max. Marks: 100

Note: Attempt any five and all questions carry equal marks.

(1) (a) Let (X,ρ) be a metric space and let a be a point in X. Let f and g be real-valued functions whose domains are subsets of X and ranges are sets of real numbers $\mathbb{R}$ with the usual metric. If $\lim_{x\to a} f(x) = L$ and $\lim_{x\to a} g(x) = M$, where $L, M \in \mathbb{R}$, then show that

(*i*) $\lim_{x\to a}[f(x) + g(x)] = L + M.$

(*ii*) $\lim_{x\to a}[f(x) - g(x)] = L - M.$

(*iii*) $\lim_{x\to a}[f(x)g(x)] = LM.$

(*iv*) $\lim_{x\to a}\frac{f(x)}{g(x)} = \frac{L}{M},\ M \neq 0.$ (CO1)

(b) Let $f : \mathbb{R} \to \mathbb{R}$ be continuous and let $f(q) = 0$ for every rational number $q \in Q$. Then, prove that $f(x) = 0$ for every real number $x \in \mathbb{R}$. (CO1)

(2) (a) Let (X,ρ) be a complete metric space and $\{F_n\}$ be a non-empty closed subset of X, for all $n \in \mathbb{N}$ such that $F_{n+1} \subset F_n$ and $diam\,(F_n) \to 0$. Then show that $\bigcap_{n=1}^{\infty} F_n$ contains exactly one point. (CO2)

(b) Define the subspace. Let (Y,ρ_Y) be a subspace of the metric space (X,ρ_X) and $A \subseteq Y$. Then prove that

(*i*) A is open in Y if and only if there exists a set G which is open in X such that $A = G \cap Y$.

(*ii*) A is closed in Y if and only if there exists a set F which is closed in X such that $A = F \cap Y$. (CO2)

(3) (a) Let (X,ρ_X) and (Y,ρ_Y) be two metric spaces. Then prove that the sequence $\{(x_n, y_n)\}$ is a Cauchy sequence in the product metric

245-

A-2

2

space $(X \times Y, \rho)$ with $\rho = \rho_X + \rho_Y$ if and only if $\{x_n\}$ and $\{y_n\}$ are Cauchy sequences in X and Y, respectively. (CO2)

(b) Define the compact metric space and show that every closed subset of a compact metric space is compact. (CO2)

(4) (a) Prove that a subset of $\mathbb{R}$ is compact if and only if it is closed and bounded. (CO2)

(b) Show that a metric space is sequentially compact if and only if it has the Bolzano-Weierstrass Property. (CO2)

(5) (a) Show that a metric space (X, ρ) is totally bounded if and only if every sequence in X contains a Cauchy subsequence. (CO2)

(b) If $f : X \to Y$ is a continuous mapping of metric spaces and (X, ρ_X) is connected, then show that $f(X)$ is connected in (Y, ρ_Y). (CO2)

(6) (a) Define the uniform continuity in metric space. Let (X, ρ_X), (Y, ρ_Y) and (Z, ρ_Z) be metric spaces and $f : X \to Y$ and $g : Y \to Z$ be uniformly continuous mappings. Then show that the mapping $g \circ f : X \to Z$ is uniformly continuous. (CO3)

(b) Show the function $f : \mathbb{R} \to \mathbb{R}$ defined by $f(x) = x^2$ is continuous but not uniformly continuous in the usual metric space $(\mathbb{R}, \rho)$. (CO3)

(7) (a) State the Weierstrass approximation theorem. Let $f : [0, 1] \to \mathbb{R}$ be a continuous function, and let $B_n(x)$ be the Bernstein function. Then prove that for each $\varepsilon > 0$, there exists $n_0 = n_0(\varepsilon) \in \mathbb{N}$ such that $|f(x) - B_n(x)| < \varepsilon$, $0 \leqslant x \leqslant 1$ and $n \geqslant n_0$. (CO4)

(b) Evaluate the following:

(i) $\sum_{k=0}^{n} \binom{n}{k} x^k (1-x)^{n-k}$

(ii) $\sum_{k=0}^{n} \binom{n}{k} x^k (1-x)^{n-k} \left(\frac{k}{n}\right)$

(iii) $\sum_{k=0}^{n} \binom{n}{k} x^k (1-x)^{n-k} \left(\frac{k}{n}\right)^2$. (CO4)

(8) (a) Discuss the deficiencies of Riemann Integral with example. (CO4)

(b) If $f : [a, b] \to \mathbb{R}$ is differentiable on $[a, b]$, and $f' \in \mathcal{R}[a, b]$, then prove that $\int_a^b f'(x)dx = f(b) - f(a)$. (CO4)

44

246

Total No. of Pages : 02

I Semester END SEMESTER EXAMINATION M.Sc.

PAPER CODE - MSMA105 Nov./Dec.-2022

TITLE OF PAPER - Ordinary Differential Equations

TIME: 03 HRS MAX. MARKS: 50

Note: Attempt any FIVE questions. Each question carry equal marks.
Assume suitable missing data, if any.

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1. State and prove Picard–Lindelöf theorem for solutions to initial value problems of first order ordinary differential equations. [10] CO-1

2. (a) Determine the singular points of the differential equation [5] CO-2

$$2x(x-2)^2y'' + 3xy' + (x-2)y = 0$$

and classify them as regular and irregular.

(b) Define Legendre polynomial $P_n(x)$. If m and n are non-negative integers such that $m \neq n$ then show that $\int_{-1}^{1} P_n(x)P_m(x)dx = 0$. [5] CO-2

3. (a) Obtain a fundamental matrix Φ for the following homogeneous system [5] CO-3

$$\frac{dx}{dt} = \begin{pmatrix} 3 & 1 & 4 \\ 0 & 2 & 6 \\ 0 & 0 & 5 \end{pmatrix} \mathbf{x}.$$

(b) Show that unique solution ϕ of the non-homogeneous vector differential equation $\frac{dx}{dt} = \boldsymbol{A}(t)\boldsymbol{x} + \boldsymbol{F}(t)$ that satisfies $\phi(t_0) = \boldsymbol{x}_0$ where $t_0 \in [a, b]$ can be expressed in the form [5] CO-3

$$\phi(t) = \Phi(t)\Phi^{-1}(t_0)\boldsymbol{x}_0 + \Phi(t)\int_{t_0}^{t} \Phi^{-1}(u)\boldsymbol{F}(u)du$$

where $\Phi(t)$ is an arbitrary fundamental matrix of corresponding homogeneous vector differential equation.

4. (a) Consider the differential equation $\frac{d^2x}{dt^2} + q(t)x = 0$ where q is continuous and $q(t) > 0$ on $a \leq t \leq b$. Let q_m denote the minimum value of $q(t)$ on $a \leq t \leq b$. Show that if $q_m > \frac{k^2\pi^2}{(b-a)^2}$, then every real solution of the given equation has atleast k zeros on $a \leq t \leq b$. [5] CO-4

(b) Transform the self-adjoint equation [5] CO-4

$$\frac{d}{dx}\left[t\frac{dx}{dt}\right] + (1-t)x = 0; \quad t > 0$$

into a Riccati equation using suitable transform. For this Riccati equation find a solution of the form ct^n. Then find a general solution of the given self-adjoint equation.

5. (a) Determine the nature of the critical point $(0,0)$ of the system [5] CO-5

$$\frac{dx}{dt} = x + y, \quad \frac{dy}{dt} = 4x + y$$

and determine whether or not the point is stable. Also, draw the phase portait.

(b) Define Wronskian for the n vector functions $\phi_1, \phi_2, \ldots, \phi_n$. Let these n vector functions are linearly dependent. Then show that $W[\phi_1, \phi_2, \ldots \phi_n](t) = 0$ for all t on $a \leq t \leq b$. [5] CO-3

6. (a) State and prove Cauchy-Peano's existence theorem for initial value problems of first order ordinary differential equations. [5] CO-1

(b) Find a series solution in powers of $(x-1)$ of Airy's equation [5] CO-2

$$y'' - xy = 0.$$

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Total No. of Pages: 03 Roll No.....

I SEMESTER

M.Sc.

END TERM EXAMINATION NOV-2022

MSMA107 Discrete Mathematics

Time: 3 Hours Max. Marks: 50

Note: Attempt any Five questions.
All questions carry equal marks.
Assume suitable missing data, if any.

Q1(a) Show that the set D_{105} of all the divisors of 105 w.r.t. the partial order relation "division" is a lattice. Is this a complemented lattice? If yes, find the complement of each element and if not, find the elements not having complement. (6) (CO1)

(b) Define Boolean algebra. Which of the following subsets of power set $\wp(S)$ of S where $S = \{a, b, c\}$, are Boolean sub algebra of $(\wp(S), \cup, \cap, ', \emptyset, S)$ and which are not? Justify the answer.

(i) $B_1 = \{\emptyset, \{a, b\}, \{a, c\}, S\}$
(ii) $B_2 = \{\emptyset, \{a\}, \{b, c\}, S\}$
(iii) $B_3 = \{\{a\}, \{a, b\}, \{a, c\}, S\}$

(4) (CO1)

Q2(a) Let $(L, \circ, +)$ be a lattice. Define a relation $' \leq '$ on L s.t.

$$a \leq b \; iff \; a \circ b = a$$

Show that $\leq$ defined above is a partial order relation on L. Also prove that $a \circ b$ is the glb of a & b. (6) (CO1)

(b) Prove that in a distributive lattice, the complement of an element, if exists, is unique. (4) (CO1,3)

Q3(a) Explain the method of constructing minimum automaton equivalent to a given automaton. Hence construct a minimum

automaton equivalent to an automaton whose transition table is given below:

State/Σ	a	b
→ q_0	q_1	q_2
q_1	q_1	q_3
q_2	q_3	q_4
q_3	q_1	q_5
q_4	q_4	q_2
(q_5)	q_5	q_5

(7) (CO3)

(b) Consider the finite state machine whose transition function δ is given by the following table

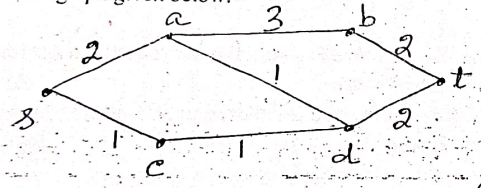
State/Σ	0	1
→ (q_0)	q_2	q_1
q_1	q_3	q_0
q_2	q_0	q_3
q_3	q_1	q_2

Give the entire sequence for the following input strings:

(i) 101101 (ii) 11111 (iii) 110101

Which strings are accepted by the machine? (3) (CO3)

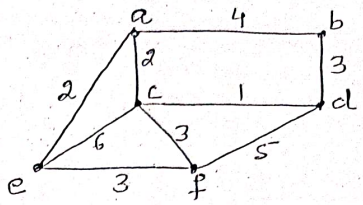
Q4(a) Apply Dijkstra's algorithm to find the shortest path from s to t for the graph given below:



(5) (CO3,4)

(b) Prove that if a graph has exactly two vertices of odd degree, there must be a path joining them. (5) (CO4)

Q5(a) Explain Kruskal's algorithm for finding Minimal spanning tree of a weighted graph and hence find the minimal spanning tree for the graph given below:



(7) (CO4)

(b) Production rules of a grammar G are given by

$S \to 0SA_1 2,\ S \to 012,\ 2A_1 \to A_1 2,\ 1A_1 \to 11.$

Test whether (i) $00112 \in L(G)$ and (ii) $001122 \in L(G)$.

(3) (CO3)

Q6(a) Rewrite the following as implications:

(i) A sufficient condition that a figure be rectangle is that it be a square.

(ii) I am a citizen of India if I am living in Delhi.

(iii) A necessary condition for Australian to win a cricket match is that they have at least two left-handed batsmen.

(3) (CO2)

(b) Is an injective function from a set to itself a surjective? Give reason for your answer. (7) (CO1)

48

250

Total no. of Pages: 02 Roll no.....

FIRST SEMESTER

M.Sc.[MATHS]

END TERM EXAMINATION *Nov -2022*

MSMA 109 MATHEMATICAL STATISTICS

Time: 03:00 Hours *Max. Marks: 40*

Note: All questions carry equal marks.
Assume suitable missing data, if any.

Q.1 (i) Give axiomatic definition of probability. [2][CO1]

(ii) Three urns contain respectively 1 white and 2 black balls; 2 white and 1 black balls; 2 white and 2 black balls. One ball is transferred from the first to the second urn; then one ball is transferred from the second to the third urn; finally one ball is drawn from the third urn. Find the probability that the ball is white. [6][CO1]

Q.2 (i) The probability density of a continuous distribution is given by:

$$f(x)=\frac{3}{4}x(2-x),\ 0<x<2$$

Compute the mean, variance and the coefficient of skewness. [3][CO2]

(ii) A random variable X has probability density function given by

$$g(x)=12x^2(1-x),\ 0<x<1$$

Compute $P(|X-m|\geq 2\sigma)$, and compare it with the limit given by Chebysheff's inequality. Here, m and σ denote the mean and standard deviation of X. [3][CO2]

(iii) State and prove weak law of large numbers. [2][CO2]

OR

If $x=4y+5$ and $y=kx+4$ be two regression equations of "x on y" and of "y on x" respectively, then find the interval in which k lies. [2][CO2]

Q.3 (i) Find the mean and standard deviation of Normal distribution. [5][CO3]

(ii) The average number of accidents on a certain section of highway is two per week. Assuming it to follow Poisson distribution, find the probability of (a) no accident on this section during a week period, (b) at most three accidents on this section during a two week period. [3][CO3]

OR

A market research agency that conducts interview by telephone was found from past experience that there is a chance of 0.4 that a call made between 2:30 PM and 5:30 PM will be answered. Calculate the probability that an interviewer's (a) 10^{th} answer will come on his 20^{th} call (b) 1^{st} answer on his 3^{rd} call. [3][CO3]

Q.4 (i) From a normally distributed population, samples are drawn of size 25. Given that the mean of the population is equal to the standard error of the sample mean. Show that the probability of the mean of a sample of size 49 drawn from the same population will be negative is 0.0808. [Given $P(|Z|<1.4)=0.4192$] [4][CO4]

(ii) Assume that 3000 male students of a university are normally distributed with mean 68.0 inches and standard deviation 3.0 inches. 80 samples consisting of 25 students each are chosen from the given male students of the same university. In how many samples, would you expect to find the mean between 66.8 and 68 inches. [Given area under standard normal curve enclosed between $z=-2$ and $z=0$ is 0.4772 and between $z=0$ and $z=0.5$ is 0.1915.] [4][CO4]

Q.5 (i) The mean of a sample of size 50 from a normal population is found to be 15.68. If it is known that the standard deviation of the population is 3.27, find the 95% confidence interval for the population mean. [Given $u_\epsilon=1.960$] [3][CO5]

(ii) A random sample with observations 65, 71, 64, 71, 70, 69, 64, 63, 67, 68 is drawn from a normal population with standard deviation $\sqrt{7.056}$. Test the hypothesis that the population mean is 69 at 1% level of significance. [Given that $P(0<Z<2.58)=0.495$]. [5][CO5]

OR

Prove that (i) $E(\bar{X})=m$, (ii) $E(S^2)=\frac{n-1}{n}\sigma^2$, where m and σ denote the mean and standard deviation of the population and n denote the sample size. $\bar{X}$ and S^2 has its usual meaning. [5][CO5]

50

252

Total No. of pages: 01

Roll No:.....

THIRD SEMESTER
M.Sc. Mathematics
END TERM EXAMINATION
November 2022

Course Code: MSMA-201 Course Title: Functional analysis

Time: 3 : 00 Hours Max. Marks: 50

Note: Attempt ANY FIVE questions. All questions carry equal marks.
Assume suitable missing data, if any.

(1) (a) Show that the set W of all polynomials on $[0, 1/2]$ is a subspace but not a closed set in the normed space $C[0, 1/2]$ equipped with the norm $\|.\|_\infty$. [5] CO#1

(b) Let V and W be Banach spaces. Prove that a sequence (T_n) of operators $T_n \in B(V, W)$ is strongly operator convergent if and only if (i) the sequence $(\|T_n\|)$ is bounded and (ii) the sequence $(T_n v)$ is Cauchy in W for every total subset M of V. [5] CO#1

(2) (a) Prove that the space ℓ^p is a Hilbert space if and only if $p = 2$. [5] CO#2

(b) Let $T : V \to W$ be a bounded linear operator from a Banach space V onto a Banach space W and let $B_0 = B(0; 1) \subset V$ be an open unit ball. Prove that $T(B_0)$ contains an open ball about $0 \in W$. [5] CO#3

(3) (a) State and prove the closed graph theorem. [5] CO#3

(b) Let V be a Banach space and W a normed space. Let (T_n) be a sequence of bounded linear operators $T_n : V \to W$ such that $(\|T_n v\|)$ is bounded for every $v \in V$. Prove that the sequence (T_n) is bounded. [5] CO#3

(4) (a) For any closed subspace W of a Hilbert space $\mathcal{H}$, prove that $\mathcal{H} = W \oplus W^\perp$. [5] CO#4

(b) Consider the operator $T : \ell^2 \to \ell^2$ defined by

$$T(x_1, x_2, \ldots, x_n, \ldots) = (0, x_1, x_2, \ldots, x_n, \ldots).$$

Show that T is linear and bounded. Find the adjoint operator T^*. [5] CO#4

(5) (a) Let V be a normed space and $T : V \to V$ a compact linear operator. Prove that the set of eigenvalues of T is countable, and $\lambda = 0$ is the only possible point of accumulation of that set. [5] CO#5

(b) Let T be a bounded linear operator on a complex Hilbert space $\mathcal{H} \neq \{0\}$. Show that the spectrum of T is nonempty. [5] CO#5

(6) (a) Let $T : \mathcal{H} \to \mathcal{H}$ be a bounded self-adjoint linear operator on a complex Hilbert space $\mathcal{H}$. Prove that the residual spectrum $\sigma_r(T)$ of T is empty. [5] CO#5

(b) Let T be a normal operator on a Hilbert space $\mathcal{H}$. Prove that (i) v is an eigenvector of T with eigenvalue λ if and only if v is an eigenvector of T^* with eigenvalue $\bar{\lambda}$, (ii) if $\lambda_1, \lambda_2, \ldots, \lambda_n$ are eigenvalues of T and $E_{\lambda_1}, E_{\lambda_2}, \ldots, E_{\lambda_n}$ the corresponding eigenspaces, then the E_{λ_i}'s are pairwise orthogonal. [5] CO#5

(7) (a) Let V be a linear space equipped with inner product $\langle ., . \rangle$. If $v_n \to v$ and $w_n \to w$ as $n \to \infty$, prove that $\langle v_n, w_n \rangle \to \langle v, w \rangle$ as $n \to \infty$. [5] CO#2

(b) If $\{e_i\}$ is an orthonormal set in a Hilbert space $\mathcal{H}$, and v is any vector in $\mathcal{H}$, show that $v - \sum \langle v, e_i \rangle e_i$ is orthogonal to e_j for each j. [5] CO#4

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End Term Examination
IV Semester (M.Sc.), November 2022
Operations Research (MSMA 203)

Max Marks: 50 Time: 3 Hours

Note: Attempt any five questions. Each question carry equal marks.

Q 1. (a) Four different jobs can be done on four different machines. The matrix below gives the cost in rupees of producing job i on the machine j.

$\downarrow \rightarrow$	M_1	M_2	M_3	M_4
J_1	5	7	11	6
J_2	8	5	9	6
J_3	4	7	10	7
J_4	10	4	8	3

How should the jobs be assigned to the various machines so that the total cost is minimized. [5][CO2, 3, 5]

(b) Use Gomory's cutting plane method to solve the following mixed integer LPP [5][CO 1]

$Maxz = 2x_1 + x_2$
subject to :

$$x_1 + x_2 \leq 5$$
$$6x_1 + 2x_2 \leq 21$$
$$x_1, x_2 \geq 0 \text{ and } x_1 \text{ is integer}$$

Q 2. Consider the following Linear ProgrammingProblem. [4+3+3][CO1]

$Maxz = 3x_1 + 4x_2 + x_3 + 7x_4$
subject to :

$$8x_1 + 3x_2 + 4x_3 + x_4 \leq 7$$
$$2x_1 + 6x_2 + x_3 + 5x_4 \leq 3$$
$$x_1 + 4x_2 + 5x_3 + 2x_4 \leq 8$$
$$x_1, x_2, x_3, x_4 \geq 0.$$

(a) solve the above problem by simplex method.
(b) analyse the optimal solution if vector B is changed to $(13, 3, 8)^T$
(c) analyse the optimal solution if cost vector C is changed to $(3, 8, 1, 7)^T$

Q 3. (a) Using graphical method calculate the minimum time to process job1 and 2 on five machines A,B,C,D and E i.e. for each machine find the job which should be done first. Also find the total time needed to complete both the jobs using following table. [5][CO2, 3, 5]

Job 1/Job 2	Sequence	corresponding Job Time
Job 1	A B C D E	1 2 3 5 1
Job 2	C A D E B	3 4 2 1 5

(b) Explain the method to evaluate optimal job sequencing for n jobs to m machines when the processing order of machines is same for each job. [5][CO2]

Q 4. (a) Consider a Game 2 person zero sum Game problem. player A chooses the strategies A_1 and A_2 and Player B chooses the strategies B_1, B_2, B_3. Following is the payoff matrix for both the payers. [5][CO2, 3]

$\downarrow Player A \rightarrow Player B$	B_1	B_2	B_3
A_1	2	4	11
A_2	7	4	2

Evaluate the optimal strategies for the players and value of the game using graphical method.

(b) Explain Dominance principle to reduce the size of Game. Give suitable example too. [5][CO2, 5]

Q 5. (a) Explain Kendall's notation for representing Queueing Models. [5][CO2]

(b) There is only one counter window at the school gate to collect the fee. The mean arrival rate is 0.80 person per minute. The mean service rate of billing and collecting money is 0.75 person per minute. If an arrival is described by poisson and service time is described by exponential. Calculate: [5][CO2, 5]

i. The probability that no one is in the system (the service is idle).

ii. The average number of units in the system.

Q 6. (a) Explain rules to draw the network diagram and also give Fulkerson I-J rule for labelling the nodes of the diagram. Give suitable example. [5][CO2, 4, 5]

(b) A small project consisting of eight activities has the following characteristics:

Activity	Preceding Activity	Optimistic time	Most likely time	Pessimistic time
A	–	2	4	12
B	–	10	12	26
C	A	8	9	10
D	A	10	15	20
E	A	7	8	11
F	B, C	9	9	9
G	D	3	4	7
H	E, F, G	5	5	5

(i) Draw the PERT network for the project. [5][CO2, 4]

(ii) Determine the critical path.

25

Total No. of Pages: 2 *Roll No.....*

3rd SEMESTER M.Sc. (Math)

END SEMESTER EXAMINATION (Nov-Dec 2022)

MSMA 211: Number Theory

Time: 3:00 Hours **Max. Marks: 50**

Note: All questions are compulsory. Assume suitable missing data, if any.

Q1. a) Show that if $\gcd(a,b)=1$, then $\gcd(a+b,a-b)=1$ or 2. [5] [CO1]

b) Prove that $28!+233\equiv 0 \pmod{899}$.

OR

Find the solutions of the system of congruences:

$$3x+4y\equiv 5 \pmod{13}$$
$$2x+5y\equiv 7 \pmod{13}$$

[5] [CO2]

Q2. a) Let $\gcd(m,n)=1$ and m and n are positive integers, then prove that $m^{\phi(n)}+n^{\phi(m)}\equiv 1 \pmod{mn}$. [5] [CO3]

b) If every prime that divides n also divides m, then establish that $\phi(nm)=n\phi(m)$ and show that in particular $\phi(n^2)=n\phi(n)$ for every positive integer n. [5] [CO3]

Q3. a) If an integer $n>1$, has the prime factorization $n=p_1^{k_1}p_2^{k_2}\ldots\ldots p_r^{k_r}$, then show that $\sum_{d\mid n}\mu(d)\tau(d)=(-1)^r$. [5] [CO3]

b) Using a table of indices for a primitive root of 11, solve the congruence: $3x^4\equiv 5 \pmod{11}$. [5] [CO4]

256

54

Q4. a) Prove that if p and q are odd primes and $q \mid (a^p - 1)$, then either $q \mid (a-1)$ or else $q = 2kp+1$ for some integer k. [5] [CO4]

b) Find the index of 5 relative to each of the primitive roots of 13. [5] [CO4]

Q5. a) Evaluate the following Legendre symbol: $\left(\frac{461}{771}\right)$. [5] [CO5]

b) Solve the quadratic congruence $3x^2 + 9x + 7 \equiv 0 \pmod{13}$.

OR

For an odd prime p, prove that there are $\frac{p-1}{2} - \phi(p-1)$ quadratic non residues of p that are not primitive roots of p. [5] [CO5]

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~~55~~ 257

Total No. of Pages: 02 Roll No:.....

THIRD SEMESTER M.Sc. [Elective]

END SEMESTER EXAMINATION NOV. 2022

MSMA213, Mathematical Modelling and Simulation

Time: 3.0 Hours Max. Marks: 40

Note: *Attempt ANY Eight questions. All questions carry equal marks. Assume suitable missing data, if any.*

1. Discuss Routh - Hurwitz criterion for the equation
$$f(s) = s^3 + as^2 + bs + c$$
and find the condition for stability. [CO-4]

2. Solve the initial value problem:
$$\frac{dX}{dt} = AX$$
Where $A = \begin{bmatrix} 3 & 2 \\ -5 & 1 \end{bmatrix}$ with $X(0) = (1, 1)^T$. [CO-2]

3. Find e^{At}, where $A = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$ [CO-3]

4. Discuss SIR model in detail. [CO-3]

5. Solve the non-homogeneous system of ODE :
$$\frac{dX}{dt} = AX + F(t)$$
Where $A = \begin{bmatrix} 6 & -3 \\ 2 & 1 \end{bmatrix}$ with $F(t) = (e^{5t}, 4)^T$. [CO-4]

217

6. Discuss the stability of the following non-linear system

$$\begin{aligned} \frac{dx}{dt} &= \sin x - 4y \\ \frac{dy}{dt} &= \sin 2x - 5y \end{aligned}$$

[CO-4]

[CO-3]

7. Define logistic model in detail.

8. Discuss the concept of bifurcation with an example of an ODE. [CO-5]

9. Draw the complete phase portrait of the linear system

$$\begin{aligned} \frac{dx}{dt} &= -2x - y \\ \frac{dy}{dt} &= 4x - 7y \end{aligned}$$

[CO-4]

10. Define Lyapunov's stability theorem with an example. [CO-5]

57

Total no. of pages: 02

259

Roll No.....

III SEMESTER

M.Sc. [Mathematics]

END TERM EXAMINATION *Nov/Dec-2022*

MSMA219 Database Management System

Time: 3 Hours *Max. Marks: 40*

Note : Questions 1-6 are compulsory. Answer any 2 in Question 7. Assume suitable missing data, if any.

Q1. State the constraints on relationships in an E-R diagram. [5][CO1, CO2]

Q2. Write an SQL query for the following schema: [3+2][CO2]

(a) Course (course_no, dep_name)
Enroll (stud_id, course_no, status)
Find the students who are enrolled in atleast one course by CS department and not enrolled in any courses offered by AM department.

(b) Project (pno, pname, budget, city)
Name the project whose budget is greater than all projects in Delhi.

Q3. Consider the following tables R, S, T, W with the following functional dependencies: [2+3][CO3]

R (A_1, B_1, C_1, D_1): {$A_1 \rightarrow B_1\ C_1\ D_1$; $C_1 \rightarrow A_1\ B_1$}

S (A_2, B_2, C_2, D_2, E_2): {$A_2\ B_2 \rightarrow C_2\ D_2\ E_2$; $C_2 \rightarrow D_2\ E_2$}

T (A_3, B_3, C_3, D_3, E_3, F_3): {$A_3 \rightarrow B_3\ C_3$; $A_3C_3 \rightarrow D_3E_3F_3$; $F_3 \rightarrow A_3\ B_3$}

W (A_4, B_4, C_4, D_4, E_4): $A_4\ B_4 \rightarrow C_4\ D_4$

For each of the above 4 tables (R, S, T, W), determine the following:

a) Find and list all the candidate keys. Notice that composite keys count as one.

b) Give the canonical cover (for each set of functional dependencies).

260

Q4. For the relation R (X, Y, Z, W, P) and the functional dependency set F = {X → Y, Y → P, and Z → W}, determine whether R is in 3NF or not? If not, convert it into 3NF. [5] [CO3]

Q5. For each of the following schedule, determine whether the schedule is conflict serializable or not: [6] [CO5]

a) $R_1(x)$, $R_2(x)$, $R_3(y)$, $W_2(x)$, $R_4(z)$, $R_3(y)$, $R_1(y)$, $R_2(y)$, $W_1(z)$, $W_1(x)$

b) $R_1(A)$, $W_2(B)$, $R_2(A)$, $W_1(B)$, $W_3(B)$, $W_1(C)$, $R_3(B)$, $W_1(A)$

c) $W_2(C)$, $R_1(A)$, $W_3(B)$, $R_1(C)$, $R_3(B)$, $R_3(A)$, $W_1(B)$

Q6. Consider the following schedules S_1 and S_2. Check whether each of these schedules is strict, cascadeless, recoverable and/or non-recoverable? [4] [CO5]

S_1: $r_1(x)$; $r_2(z)$; $r_1(z)$; $r_3(x)$; $r_3(y)$; $w_1(x)$; c_1; $w_3(y)$; c_3; $r_2(y)$; $w_2(z)$; $w_2(y)$; c_2;

S_2: $r_1(x)$; $r_2(z)$; $r_3(x)$; $r_1(z)$; $r_2(y)$; $r_3(y)$; $w_1(x)$; c_1; $w_2(z)$; $w_3(y)$; $w_2(y)$; c_3; c_2;

Q7. Write a short note on the following (Any 2): [5+5] [CO4, CO5]

a) Concurrency control techniques

b) Indexing and types of indexing

c) B and B+ trees

261

Total No. of Pages : 01

I-SEMESTER
B.Tech.

Roll No.....

END TERM EXAMINATION

NOV-2022

MSHU 113 COMMUNICATIVE ENGLISH

Time: 3 Hours

Max. Marks: 50

Note: Answer any five questions.
All questions carry equal marks.
Marks are indicated against each question.
Assume suitable missing data, if any.

1. Define dialogue. Distinguish between dialogue and debate. (10) (CO2)
2. What is interview? What are the major essentials for interviewee? (10) (CO1)
3. Bring out the major characteristics of presentation. (10) (CO2)
4. Present the phonemic transcription of **any ten** of the following words: (10) (CO3)
   Teacher, Caption, Absolute, Democracy, National, Character, Friend, Clever, Truth, Deliver, Optimist, Creation, Legacy
5. Write two words each with the symbols: /i:/, /u/, /ei/, /e/, /u:/ (10) (CO1)
6. Discuss the major types of writing. Illustrate your answer. (10) (CO3)
7. Define notice as a formal communication. Write a notice about the hike of annual fee for students of B.Tech. Imagine relevant details. (10) (CO4)
8. Distinguish between a CV and a resume? Prepare a CV of your own. (10) (CO4)
9. Write a report on the post pandemic situation in India. Imagine relevant details. (10) (CO4)
10. Write short notes on **any two** of the following: (10) (CO3)

    a) Memo
    b) Place of Articulation
    c) Cover Letter
    d) Good and Bad Newsletters

-50

Total no. of Pages 02

Roll no..... 262

First Semester
M.Sc.

END TERM EXAMINATION Nov.2022

MSBT 101 Biochemistry

Time: 3 Hours *Max.Marks: 40*

Note: All questions are compulsory

Q.1 Attempt any *four* of the following: 1X4=4 [CO 1]

a. Hydrophobicity
b. Insulin
c. Biologically active amino acids
d. Chymotrypsin
e. Dialysis
f. Buffers

Q.2 Attempt **all** questions. 2 X 4= 8 [CO 5]

a. Describe the anaerobic conversion of pyruvate to lactate with example and reactions involved.
b. Analise the fate of galactose and fructose to pyruvate conversion. Describe with pathway.
c. What is Pyruvate dehydrogenase and what are it's function. In cell where it is located.
d. Draw the structure of glutathione and describe the functions.

Q.3 Attempt **any four** questions. 2 X 4= 8 [CO 4]

a. Explain integral proteins, types, and functions.
b. Discuss three types of motion of single phospholipids in a bilayer with diagram.

263

-61-

c. What are nucleotides, how they are arranged in DNA structure. Explain with diagram
d. Elaborate the DNA sequencing method.
e. Central dogma of molecular biology

Q.4 Write short note on **all** with diagram. 1.5 X 6= 9 [CO 3]

a. Aldoses
b. Phospholipids
c. Lipoproteins
d. Hemiacetals and Hemiketals
e. Glycosidic bond
f. Reducing and no reducing sugars

Q.5 Explain enzyme kinetics. Derive the expression of Michaelis-Menten kinetics how the linearisation of t's curve is done. 3 [CO 3]

Q.6 Draw and describe Pentose phosphate pathway with phases involved. 4 [CO 6]

Or

Draw and discuss Calvin cycle. What is the location. Why is it called dark reaction?

Q.7 Differentiate between any two of the following: 2X2=4 [CO 5; CO 6]

a. Oxidative phosphorylation and Oxidative phosphorylation
b. Active and Passive transport
c. Glycolysis and Gluconeogenesis

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62

264

Total no. of Pages:2 Roll no.....

Ist SEMESTER

M.Sc. Biotechnology

END TERM EXAMINATION *Nov/Dec-2022*

COURSE CODE: MSBT103 **Cell & Developmental Biology**

Time: 03:00 Hours *Max. Marks: 50*

Note : All questions carry equal marks.
Assume suitable missing data, if any.

Q.1 Write short notes on: [10] [CO 1 ; 2]

(i) Membrane carbohydrates
(ii) Atomic Force Microscopy
(iii) Cell cycle check points
(iv) Nucleus
(v) Chromatin organization

Q.2 Write short notes on: [5] [CO 3]
(i) Lysosomes
(ii) Microbodies

(b) Describe the structure, functions and significance of extracellular matrix in plants and animals [5]

Q.3 Write short notes on: [10] [CO 4]
(i) Zygotic gene effects
(ii) Differentiation of germ layers
(iii) Cellular polarity
(iv) Maternal gene effects
(v) Homeotic gene effects in Drosophila.

265

63

Q.4 Explain any TWO of the following: [10] [CO 5]

(i) Heterosis and Apomixis
(ii) Tumor suppressor genes and oncogenes
(iii) Mating cell types in yeat
(iv) Sex-determination in Drosophila

Q. 6 Describe in brief the "cells of the immune system". [10] [CO 5]

Total No. of Pages: 3

Roll No. .....

M.Sc.

FIRST SEMESTER

END TERM EXAMINATION *November-2022*

MSBT 105 Molecular Biology

Time: 03:00 Hours *Max. Marks: 40*

Note: Answer all the questions.
Assume suitable missing data, if any.

Q.1 [A] Attempt any TWO of the following [2+2] [CO1]

(i) Design a strategy to analyze the repetitiveness of DNA sequences based on $cot_{½}$ value. How is $cot_{½}$ correlated to genome complexity?

(ii) Give a descriptive account of the structure and formation of metaphase chromosome. Explain with the help of well-labelled diagram

(iii) Describe the structure of nucleosomes. Also explain nucleosome phasing with respect to the transcription start site (TSS)

[B] Analyze the specificity of vesicular trafficking with respect to cargo selection, vesicle budding, and vesicle fusion to target membrane. Clearly indicate the roles of various proteins involved. Support your answer with suitable well-labelled diagrams [4] [CO4]

Q.2 [A] Attempt any TWO of the following [2+2] [CO2]

(i) Mismatch repair in prokaryotes depends on the methylation status of DNA. Explain the mechanism of prokaryotic mismatch repair of DNA lesion and the role of methylation in the process

(ii) Write short notes on the following

(a) Watson-Crick base pair – draw and mention the positions of atoms involved in H-bond formation

(b) Cre-*lox* mediated recombination

(iii) Assign explanation(s) for the following in ~60 words each

(a) DNA Pol I acts on two Okazaki fragments simultaneously and is capable of nick translation

(b) DNA ligase requires cofactor for its activity

P.T.O.

[B] Answer the following [2+2] [CO2, CO4]

(i) Assign explanation(s) for any two of the following in ~60 words each
  (a) DnaB helicase requires ATP for its function
  (b) Leading and lagging strands of DNA are synthesized simultaneously by DNA Pol III in a manner analogous to Trombone
  (c) DNA triple helix formation

(ii) Discuss about the following in detail
  (a) Signal recognition particle (SRP), SRP-receptor, Sec 61
  (b) Wobble hypothesis

Q.3 [A] Attempt any TWO of the following [2+2] [CO3]

(i) Assign explanation(s) for the following in ~60 words each
  (a) Acetylation of histones enhances transcription
  (b) CTD tail of RNA Pol II plays important roles in transcription and post-transcriptional processing

(ii) Give a descriptive account of general transcription factors involved in the transcription catalyzed by RNA Pol II

(iii) Discuss the mechanism of antitermination and attenuation, taking example of *trp* operon

[B] Attempt any TWO of the following [2+2] [CO3]

(i) Give a descriptive account of the control of *lac* operon by repressor-inducer system. Clearly describe the structure of Lac repressor and its site(s) of binding. What is the inducer and how is it formed?

(ii) Write short notes on the following
  (a) Enhancer
  (b) Role of double stranded RNA in gene silencing

(iii) Give a flowsheet representation to show the mechanism of catabolite repression. Also draw diauxic curve to explain catabolite repression

Q.4 [A] Attempt any TWO of the following [2+2] [CO4]

(i) Explain the following in ~60 words each
  (a) Formylation of initiator methionine increases the efficiency of prokaryotic translation
  (b) Shine Dalgarno sequence helps in initiation of translation from 5' end of prokaryotic mRNA

P.T.O.

(ii) Write in brief about the following
  (a) Conformational changes in *cis* ring of prokaryotic chaperonin leading to substrate protein folding and release from chaperonin
  (b) Translocation step of prokaryotic translation and effects on interactions between various types of RNAs on ribosome

(iii) Describe any two of the following
  (a) Significance of eukaryotic mRNA circularization in translation
  (b) Ubiquitination targets the proteins for proteasomal degradation
  (c) Localization of eukaryotic ribosome at the 5' end of mRNA and start codon during translation

[B] Specify the functions of any three proteins / RNAs that participate in the post-transcriptional processing of eukaryotic RNAs. Take one example each from post-transcriptional processing of mRNA, tRNA and rRNA. Explain in brief the processes in which each is involved [4] [CO4]

Q.5 [A] Attempt any TWO of the following [2+2] [CO5]

(i) Assign reason(s) to any two of the following
  (a) Concentration of p53 rises at the time of DNA damage
  (b) Role of phosphorylation status of pRb in cell cycle

(ii) Explain the following statements
  (a) Mutations in tumor suppressor genes are usually recessive in their effects on the individual cell
  (b) A retrovirus can transform a host cell by inserting its DNA next to a proto-oncogene of the host

(iii) Compare and contrast the following, giving 2 points for each
  (a) Conservative transposition and Replicative transposition
  (b) G1 checkpoint and G2 checkpoint

[B] Answer the following questions [2+2] [CO5]

(i) Briefly describe any two of the following
  (a) Frameshift mutation and Point mutation
  (b) Mechanism of action of any two chemical mutagens

(ii) What are proto-oncogenes? Describe the mechanism of conversion of proto-oncogene into oncogene in chronic myelogenous leukemia [4] [CO5]

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268

Total no. of Pages: 02

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1st SEMESTER

M.Sc. BIOTECHNOLOGY

END TERM EXAMINATION *Nov/Dec-2022*

MSBT107 **ANALYTICAL TECHNIQUES**

Time: 03:00 Hours *Max. Marks: 40*

Note: All questions carry equal marks.
Assume suitable missing data, if any.

Q.1 a) Explain briefly the principle and instrumentation of Fluorescence Spectrophotometer.

b) What do you understand by FRET? Explain with an example how can FRET be used to study interactions in live cells. [4][CO 1]

Q.2 a) Explain with an example the principle and advantages of using Affinity Chromatography in the purification of proteins. [4][CO 2]

Q.3 What is the basic principle involved in Electrophoresis? How is 2D Electrophoresis performed to separate proteins from a mixture and what is its advantage over 1D gel electrophoresis? [4][CO 2]

Q.4 a) What are the differences in the instrumentation and applications of preparative and analytical Ultracentrifugation techniques?

b) How can you determine the molecular mass of a particle using Sedimentation Equilibrium method? [4][CO 3]

Q.5 a) Give points of differences between Rate Zonal technique and Isopycnic technique while performing density gradient centrifugation.

b) If ultracentrifuge speed is 60000 rev/min., calculate

(i) the angular velocity (ω in radian per second) and the centrifugal field, G, at a point equivalent to 5.2 cm from centre of rotation.

(ii) How many 'times g' is this equivalent to? [4][CO 3]

Q.6 Explain the principle, instrumentation and working of a Geiger-Muller counter OR a Scintillation counter for detection of radioactivity. [4][CO 4]

Q.7 a) Explain briefly any 2 applications of radioisotopes in biological studies.

b) How is Isotope Dilution analysis performed? [4][CO 4]

Q.8 Write briefly:

(i) Why is MALDI-TOF considered as a 'soft' ionization technique?

(ii) Why is vacuum required during operation of a mass spectrometer?

(iii) What do you understand by 'ablation'?

(iv) What is the relevance of 70eV energy associated with accelerated electrons while using Electron Impact ionization technique?

[4][CO 5]

OR

Q.8' Describe in detail how MALDI-TOF can be used to characterize mixture of organic molecules. [4][CO 5]

Q.9 With the help of schematic diagrams, explain the difference in Electron Impact and Electrospray Ionisation techniques used in mass spectroscopic analysis. [4][CO 5]

OR

Q.9' Explain in detail any 2 methods of enzyme/cell immobilization. Mention 2 industrial applications of this technique. [4][CO 5]

Q.10 a) What are the steps involved to determine the 3D structure of a protein through X-ray crystallography?

b) What are the 2 ways in which vapour diffusion can be performed? [4][CO 5]

270

Total no. of pages: 2 Roll no. .....

First Semester M.SC BIOTECHNOLOGY

End-term examination November 2022

COURSE CODE: MSBT 109

COURSE TITLE: Biostatistics and Computer Application

Time: 3 hours Max marks: 50

Note: Use of statistical table or scientific calculator is allowed.
All questions are compulsory.

Question 1: Attempt *any two* from the following: **(3 X 2= 6 marks)[CO# 3,4,5]**

a. What is a microarray? Discuss its important steps or process of microarray data analysis.?
b. Discuss phylogeny or phylogenetic associations. Explain mono-, poly-, and para-phyletic groups.?
c. Discuss Homology modeling and key steps involved in the process.?

Question 2: Differentiate *any three* from the following: **(2 X 3= 6 marks)[CO# 1,2]**

a. A null and alternate hypothesis
b. Type I and Type II error
c. Primary and secondary databases
d. Descriptive and inferential statistics

Question 3: In the sample space S, if two events A and B occur, which are not mutually exclusive. Then represent them with a Venn diagram, and with correct representations: (A'∩ B'); (A ∩ B'); (A ∩ B); (B ∩ A').? **(5 marks) [CO# 1]**

Question 4: Define the following terms: **(10 marks) [CO# 1,2,3,5]**
Candidate Key; Clade; Docking; Biostatistics; Relative Cumulative Frequency Curve; DBMS; MySQL; Parsimony; Tuple; Mutually exclusive events

Question 5: Attempt *any three* of the following: **(4 X 3= 12 marks) [CO# 1,2,3]**

a. Discuss clustering and its common types.?
b. A bag contains 10 white and 5 black balls. Two balls are drawn at random one after the other without replacement. Find the probability that both black balls are drawn.?
c. The probability that a boy will get a scholarship is 0.9 and that a girl will get is 0.8. What is the probability that at least one of them will get the scholarship.?

d. Discuss the utility of at least three Boolean operators, which are used during literature search strategy on databases such as PUBMED.?

Question 6: For a random sample of 10 patients, who were fed on a Ketogenic diet, and were observed to have an increase in overall body weight in kilograms, which is as follows: 10,6,16,17,13,12,8,14,15,9. Likewise, another set of 12 healthy controls was fed on the same diet, and they also reported an increase in weight, as follows: 7,13,22,15,12,14,18,8,21,23,10,17.Since both groups reported an increase in weight. Therefore, test the hypothesis of whether the effect of the ketogenic diet significantly differs among the two groups of individuals (patients Versus Controls) or not. The degrees of freedom for 20, 21, and 22 are 2.09, 2.08, and 2.07 respectively at a 5% level of significance. {For further calculation: square root of 21.7 and 5.454 is 4.658 and 2.335, respectively. Also, 7 divided by 4.658 is 1.503.} **(5 marks) [CO# 1]**

Question 7: Explain the properties of normal distribution. Discuss positively and negatively skewed data.? **(3marks) [CO# 1]**

Question 8: Write a flow chart showing the steps in the compilation of a high-level language program in a database: We want to see which number is larger from the three numbers W, Q, R. Compare W with Q. If W is larger, compare it with R. If W is found larger than R, it means W is the largest number; otherwise, R is the largest number. If in the first step W is smaller than or equal to Q, then Q is compared with R. Now, If Q is larger than R, then Q is the largest number else R is the largest number. **(3marks) [CO# 2]**

70

212

Total No. of Pages 02

Roll No. .....

THIRD SEMESTER

M.Sc. [MSBT]

END SEMESTER EXAMINATION NOV-2022

MSBT 201: Bioprocess Engineering & Technology

Time: 3:00 Hours Max. Marks: 40

Note: Answer ALL questions.
Assume suitable missing data if any.

Q. 1 Define the term Nabla factor. Explain growth associated product formation with the help of diagrams. [1+3=4] CO 1

Q.2 (a) What is turbidostat. Describe an air-lift bioreactor with a neat and labelled diagram along with its advantages over conventional bioreactor. [2+4=6] CO 2

[b] CSTR volume 750 L contains 8g/L glucose as a feed flowing with flow rate of 150 L/h. Microbial system follows Monod model with μ_m= 0.4 h^{-1}, Ks = 1.5 g/L, Yx/s= 0.5 g cell mass/g substrate. Determine cell produced at steady state condition. [4] CO2

Q. 3 (a) In a fermentation process producing baker's yeast, the biomass is separated using a continuous centrifuge, operating at 4000 rpm, with a feed rate of 80 l/min. The solid particles may be assumed to have an average diameter of 0.05 mm. The density of the biomass is 1010 kg/m^3. The fluid may be assumed to have properties of water. Find the sigma factor for the centrifuge. [5] CO 3

(b) Discuss the principle and equipment's used in drying during product recovery. [6] CO 3

Q. 4 (a) Explain the mechanism of enzymatic reactions during starch and sugar conversion processes.

OR

What is HFCS? Explain how fermentation is a method of preparing and preserving foods. [5] CO 4

(b) Discuss the role of microbes in fermentation industry. [6] CO 4

Q. 5 A marine microorganism contains an enzyme that hydrolyzes glucose-6-sulphate (S). The assay is based on the rate of glucose formation. The enzyme in a cell-free extract has kinetic constants of $Km = 6.7 \times 10^{-4}$ M and $V_{max} = 300$ nmoles X liter^{-1} X min^{-1}. Galactose-6-sulphate is a competitive inhibitor (I). At 10^{-5} M galactose and 2×10^{-5} M glucose-6-sulphate, v was 1.5 nmoles X liter^{-1} X min^{-1}. Calculate Ki for galactose-6-sulphate. [4] CO 5

~~12~~ 274

Total No. of Pages : 02 Roll No.....

III SEMESTER

M.Sc. (Biotechnology)

END TERM EXAMINATION *Nov-2022*

MSBT203 : Immunotechnology and Molecular Virology

Time: 3 Hours *Max. Marks: 50*

Note: Attempt 5 questions in total. Question 1 is compulsory. Assume suitable missing data, if any.

Q. 1 Answer all the following questions:

[a] Enlist and discuss in brief any 3 factors that influence the immunogenicity of any substance. [3] [CO#1]

[b] What is a biosensor? Differentiate between sensitivity, detection limit and specificity of a biosensor. [3] [CO#2]

[c] Differentiate between Type 2 and Type 3 hypersensitivites. Provide any 3 differences. [3] [CO#3]

[d] Which retrovirus affects immunity in the human body? Name the primary cell type and the disease that it causes. [3] [CO#4]

[e] Is it possible to determine the presence of virus in a sample using RBCs? If yes, what is the technique that is utilized? [3] [CO#5]

[f] What is the significance of MHC for transplantation? [3] [CO#3]

Q. 2[a] Discuss in brief the significance of adjuvants in vaccine development. Can a TLR ligand be used as an adjuvant? Explain. [4][CO#1]

[b] For an ELISA, antibodies against Vitamin D are required. However, Vitamin D only does not elicit an immune response.

275

Discuss one strategy that can be utilized to produce antibodies against this vitamin. [4] [CO#1]

Q. 3[a] Enumerate any 5 differences between Class I and Class II MHC receptors. [5] [CO#3]

[b] Which cell type is involved in delayed-type hypersensitivities? What is the role of the primary mediators in the allergic response? [3] [CO#3]

Q. 4 [a] Define a virus. Enumerate the properties shared by most viruses. [4] [CO#4]

[b] HIV is included in which class/family of viruses? Which cell type(s) is(are) primarily infected by HIV? Enlist and discuss in brief any 2 methods for diagnosis of HIV. [4] [CO#4]

Q. 5 [a] Enumerate the steps involved in plaque assays for counting of virus infected particles. Can plaque assays be conducted if virus does not kill cells? [4] [CO#5]

[b] Which technique can be utilized for detecting viral proteins in body fluids? Discuss in brief the steps involved. [4] [CO#5]

Q. 6 Enumerate any 4 advantages of DNA vaccines. Consider a hypothetical situation involving the design of a peptide vaccine against HIV. Which method would you utilize to test the efficacy of the vaccine and how? [4+4 = 8] [CO#1,4]

Q. 7 [a] Name one technique that can be utilized to calculate the affinity rate constant of antigen-antibody interactions. Briefly discuss the steps involved. [4] [CO#2]

[b] Is there a technique that can be utilized to detect viral/bacterial DNA in a given sample? If yes, detail the main steps involved. [4][CO#2,5]

276

Total no of pages: 2 Roll No:

3rd_ SEMESTER **M.Sc. [BT]**

END SEMESTER EXAMINATION *Nov 2022*

MSBT 205 : IPR & Biosafety

Time: 3:00 Hours *Max. Marks : 50*

Note : Answer all questions. Assume suitable missing data, if any.

1. Give suitable reasons and explanations for the following answers: [4x3] Answer any 4 questions. (CO# 1)

   (a) Bioethics is normative ethics and breach of ethical principle has led to punitive action.
   (b) TRIPS agreement platform has led to sharing of patent benefits in all member countries but is not without a price.
   (c) Regulations regarding GMO is different in different countries
   (d) Trademark violation can be on the basis of market presence even if it is not registered.
   (e) Patent is a government given monopoly awarded by a specific government where the patent has been filed. However a PCT application (Patent Cooperation Treaty) is an international patent, binding on all WTO member countries.

2. Attempt any 4 questions of the following: [4x3] (CO #1, 2)

   (a) Describe the patent application procedure in India.
   (b) How is 'prior art' crucial for granting of patent and to prevent post-grant opposition?
   (c) How is copyright different from patent? Enumerate using examples how copyright violation is of several types and can be a cause of litigation?
   (d) Patents, trademarks and copyrights are for different purposes, explain. In case an inventor has patented a particular computer chip in a country which allows patent on computer chips and is applying for protection of his monopoly in India by way of trademark, is he legally correct? Give suitable explanation for your answer.
   (e) What is a geographical indicator? How are regulatory trademarks different from individual company trademarks? Give suitable examples.

3. Write detailed factual data for the following case studies. Attempt any 3 questions of the following: [3x3] (CO# 3)

277

(a) Evergreening of patents
(b) Patent violation on the basis of traditional knowledge
(c) Post-grant opposition of patent, leading to retraction of patent
(d) Drug repurposing to side-step patent restriction

4. Attempt any 2 questions of the following: [2x3] (CO# 4)

(a) What are the different stages of clinical trials? How does one ensure that the cohort chosen for a clinical trial is justified, discuss using examples.
(b) How is placebo different in prophylactic and therapeutic trials?
(c) What are concurrent controls? Can we conduct retrospective clinical trials? What is informed consent?

5. Write short notes on the following: (All questions are compulsory) (CO#5)

(a) Triple packaging [2]
(b) Biosafety facility Level II [2]
(c) Biosafety Level III and IV [2]
(d) Consequences of indiscriminate use of genetically modified crops [2]
(e) Historical background for regulations for Biosafety and Bioethics [3]

tal no. of pages: 3 Roll No.....

IIRD SEMESTER M. Sc. (BIOTECHNOLOGY)

ID SEMESTER EXAMINATION (NOV-2022)

MSBT-217 NANOBIOTECHNOLOGY

ne: 3.00 Hours Max. Marks: 50

ote: Answer all of the following question
ssume suitable missing data, if any.

1. All questions are Compulsory, answer briefly.

[(2×8) CO-2, 3, 4, 5]

a. Write down two biomaterials each for the designing of scaffolds of muscles, neurons, adipose and cardiovascular system.

b. List two advantages and two disadvantages of positive and negative photoresist. What are the common applications of each?

c. Calculate the time required to remove a 250 μm thick silicon layer from the surface of a <100> wafer. The etchant is KOH with an approximate oxide etch rate of 0.25 μm/min.

d. What are homing peptides, write down two homing peptides used in cancer treatment.

e. Briefly explain bio-reduction mechanism for synthesis of silver nanoparticle using microbes.

f. Briefly explain the mechanism of microwave assisted one-pot synthesis of metallic nanostructure in solution.

g. Describe co-precipitation in nano synthesis using suitable example.

h. The LD50 for 20 nm silver nanoparticles is estimated to be about 354 mg/kg.

I. Worldwide, the average weight of an adult is 137 lb. What is this weight in kg,

II. Calculate the lethal dose of 20 nm silver nanoparticles for an average adult, in mg.

278

Q 2. Attempt any five of the following questions [(4×4) CO-2, 3. 4, 5]

a. Describe the principles behind the Czochralski method for silicon manufacturing.
b. State the difference between wet and dry etching process. Write down three anisotropic etchants and mention the reaction mechanism of any one?
c. Describe lab-on-a-chip, discuss about its fabrication process and explain its application in medical diagnostics.
d. Explain the principle of biobarcode assay. What are its advantages and significance in current scenario?
e. Define LD_{50} and LC_{50}, describe ROS induced lipid peroxidation inside cell.
f. Give the details on Etch stop methods in microfabrication technology.
g. Elaborate on therapeutic application of carbon nanotubes; why only carbon nanotubes out of tremendous nanocarriers.
h. Briefly describe the each of the following Etch parameter on the Etch profile of the microstructure in RIE chamber
   I. Plasma
   II. Pressure
   III. Gases

Q 3. Attempt any one out of the following questions [(6) CO-3, 5]

a. Define Biomaterials and along with its classification briefly describe, what is the significance of cell-surface interactions in the area of regenerative medicine, discuss the application of biomaterials in implants and prosthesis.

OR

b. What is tissue engineering and how tissue engineering methods are currently being implemented in regenerative medicines, discuss about strategies applied development of artificial skin?

OR

c. What is nanotoxicology? How does nanomaterial affect the vital organs of the body, briefly explain the toxicological mechanism of nanomaterials. How to estimate the potential hazard related to nanoparticles.

Q 4. Answer any one [(6) CO-4, 5]

a. What is biosensor, briefly describe the different components and types of biosensors and explain their applications with suitable examples of target analytes.

OR

b. What are the different modes of detection in biosensors, what are electrochemical transducers and explain their applications in different types of biosensors with suitable examples of target analytes.

OR

c. Briefly discuss the role of nanomaterial in clinical diagnostics and treatment of cancer, what are its advantages and significance in current scenario?

Q 5. Answer any one [(6) CO-2]

a. Discuss about the biosynthesis of metallic nanomaterials using plant derivatives, In addition explain the pharmacological properties of metallic nanomaterials.

OR

b. Briefly describe the various techniques involved in liquid based synthesis of nanomaterial. How can we get 0-D, 1-D, 2-D and 3-D nanostructures using nanosynthesis methods, explain with suitable example.

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78

Total no. of Pages: Roll no 280

END SEMESTER

M.Sc

END TERM EXAMINATION Nov/Dec-2022

MSBT-241 MOLECULAR THERAPEUTICS

Time: 03:00 Hours *Max. Marks: 50*

Note : All questions carry equal marks.
Assume suitable missing data, if any.

Q.1 What is the difference between gene therapy and cellular therapy? Explain the viral and non viral vectors of gene therapy. Design gene therapy strategy against any disease of your choice with emphasis on the signalling pathway targeted. [10][CO1]

Q.2 Describe the pros and cons of using recombinant human growth hormone. Mention ten other applications of recombinant technology. [10][CO2]

Q.3 Differentiate between thrombosis and atherosclerosis. Design molecular therapy for thrombosis, atherosclerosis and fibrinolysis. What is the side effect of blood thinner administered for a long time to patients? [10][CO3]

Q.4 Name five cytokines used for therapy in cancer. Explain individual cytokine therapy versus combinatorial cytokine therapy for cancer using diagram. Name one vaccine used for cancer. [10][CO4]

Q.5 "RNAi mediated oncogene silencing confers resistance to tumourigenesis" Comment on the given statement explaining the type of oncogene silenced and its effect on associated signalling pathway. [10][CO5]

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