COOCH BEHAR PANCHANAN BARMA UNIVERSITY

B.Sc. Honours 6th Semester Examination, 2021

MATHEMATICS

DYNAMICS OF PARTICLE

CORE-13

Time Allotted: 2 Hours | Full Marks: 40

The figures in the margin indicate full marks.
All symbols are of usual significance.

Answer any *two* questions 20×2=40

1. (a) A particle is attracted by a force to a fixed point varying inversely as the *n*th power of the distance; if the velocity acquired by it in falling from an infinite distance to a distance '***a***' from the centre is equal to the velocity that would be acquired by it in falling from rest at a distance '***a***' to a distance $\frac{a}{4}$, show that $n=\frac{3}{2}$. 10

   (b) A particle, of mass *m*, is projected vertically upwards under gravity, the resistance of the air being *mk* times the velocity. Show that the greatest height attained by the particle is $\frac{V^2}{g}[\lambda-\log(1-\lambda)]$; where *V* is the terminal velocity of the particle and λV is its initial vertical velocity. 10

2. (a) A point starts from the origin in the direction of the initial line with velocity $\frac{f}{a}$ and moves with constant angular velocity '***a***' about the origin and with constant negative radial acceleration *–f*. Show that the rate of growth of the radial velocity is never positive, but tends to the limit zero, and prove that the equation of the path is $a^2r=f(1-e^{-\theta})$. 10

   (b) If a planet were suddenly stopped in its orbit, supposed circular, show that it would fall into the Sun in a time which is $\frac{\sqrt{2}}{8}$ times the period of the planet's revolution. 10

3. (a) A particle moves with a central acceleration $\mu(r^5-c^4r)$; being projected from an apse at distance '*c*' with a velocity $\sqrt{\frac{2\mu}{3}}c^3$. Show that the path is described by $x^4+y^4=c^4$. 10

   (b) A heavy chain, of length *l*, is held by its upper end so that its lower end is at a height *l* above a horizontal plane; if the upper end is let go, show that at the instant when half the chain is coiled up on the plane the pressure on the plane is to the weight of the chain in the ratio of 7:2. 10

——×——

COOCH BEHAR PANCHANAN BARMA UNIVERSITY

B.Sc. Honours 6th Semester Examination, 2021

PHYSICS

ELECTROMAGNETIC THEORY

CORE-13

Time Allotted: 2 Hours | Full Marks: 25

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.
All symbols are of usual significance.

Answer any *one* question from the following 25×1 = 25

1. (a) State the boundary conditions to be satisfied by electromagnetic field vectors **E, D, B** and **H** at the plane interface of two media. 6

   (b) A plane e.m. wave is incident obliquely on a boundary between media of different electric and magnetic properties. Derive Fresnel's equations for the cases when, electric field, **E** is (i) perpendicular and (ii) parallel to the plane of incidence. Hence prove Brewster's law in case of polarization by reflection. 7+7+5

2. (a) What is meant by an elliptically and a circularly polarized light? How are elliptically and circularly polarized light can be produced experimentally? 6+8

   (b) What is rotatory polarization? Give theory of optical rotation. 3+8

——×——

COOCH BEHAR PANCHANAN BARMA UNIVERSITY

B.Sc. Honours 6th Semester Examination, 2021

CHEMISTRY

INORGANIC CHEMISTRY-IV

CORE-13

Time Allotted: 2 Hours | Full Marks: 25

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.
All symbols are of usual significance.

Answer any *one* question from the following 25×1=25

1. (a) How would you distinguish between bridging and terminal CO in carbonyls? 3
   (b) What is the expected product when $Co_2(CO)_8$ was treated with NO? Provide explanation. 3
   (c) Find out the value of x in $Co_2(CO)_x(C_2H_2)$. 2
   (d) CO cannot form complex with H^+ but can form with Fe — Explain. 3
   (e) Arrange the following in the increasing order of back bonding 3
   (i) $Cr(CO)_6$ (ii) $[Mn(CO)_6]^+$ (iii) $[Ti(CO)_6]^{2-}$ (iv) $[V(CO)_6]^-$
   (f) Predict the product with chemical equations. 4
   (i) To a dry THF solution of $Co_2(CO)_8$, Na-amalgam is added and refluxed.
   (ii) CH_3Br is added to $Na_2Fe(CO)_4$ solution in THF.
   (g) What is metathesis reaction? 2
   (h) How does the mode of chemical reactivity change when free alkene is coordinated towards transition metal? 2
   (i) Write about the structure and bonding of Zeise's salt. 3

2. (a) Write the stereochemistry of the intermediate (with a brief explanation) when $K_2[PtCl_4]$ was treated with ammonia. 2
   (b) How would you show the rapid interchange of alkyl groups present in $Al_2(CH_3)_6$? 2
   (c) Draw the most stable structure of the oxidative addition product of Vaska's complex with O_2 molecule — Explain. 2
   (d) Hydroformylation reaction should be considered as the hydrocarbonylation reaction — Explain. 2
   (e) Draw the structure and stereochemistry of the product when $Co_2(CO)_8$ is treated with H_2. — Explain. Mention also application of that product in organometallic chemistry. 4
   (f) Manganese cannot form mononuclear homoleptic neutral carbonyl — Explain. 2
   (g) How ferrocene could be prepared? Why it could not undergo nitration reaction similar to that of benzene? Show how nitro ferrocene could be prepared. 2+2+2
   (h) What are spectator ligands? How does the ligand cone angle of phosphine derivatives influence the substitution reaction of organometallic compounds? 1+3
   (i) Give one limitation of 18-electron rule. 1

——×——

COOCH BEHAR PANCHANAN BARMA UNIVERSITY

B.Sc. Honours 6th Semester Examination, 2021

MATHEMATICS

NUMERICAL METHODS

CORE-14

Time Allotted: 2 Hours | Full Marks: 25

The figures in the margin indicate full marks.
All symbols are of usual significance.

Answer any *one* question 25×1 = 25

1. (a) Deduce Lagrange's interpolation formula for $(n+1)$ number of points. 9

   (b) Find the missing term from the following table: 8

x	0	1	2	3	4
$f(x)$	1	3	9	___	81

   (c) Find a real root of the equation $x^3-9x+1=0$ by Bisection method correct upto two decimal place. 8

2. (a) Use Runge-Kutta method of order four to approximate y, when $x=1.1$. Given that 9

$$\frac{dy}{dx}=3x+y^2 \ , \quad y(1)=1.2$$

   (b) Establish Trapezoidal rule for numerical integration. 8

   (c) Evaluate $\int_0^1 \sqrt{1-x^2}\,dx$ using Simpson's $1/3$ rule for $n=6$. 8

——×——

COOCH BEHAR PANCHANAN BARMA UNIVERSITY

B.Sc. Honours 6th Semester Examination, 2021

PHYSICS

STATISTICAL MECHANICS

CORE-14

Time Allotted: 2 Hours | Full Marks: 25

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.
All symbols are of usual significance.

Answer any *one* question from the following 25×1 =25

1. What is Bose-Einstein statistics? What are the basic postulates used? Derive an expression for the most probable distribution of the particles of a system obeying Bose-Einstein statistics.

2. Discuss Gibbs paradox by deriving necessary equations. Obtain Sackur Tetrode equation from it.

——×——

COOCH BEHAR PANCHANAN BARMA UNIVERSITY

B.Sc. Honours 6th Semester Examination, 2021

CHEMISTRY

PHYSICAL CHEMISTRY

CORE-14

Time Allotted: 2 Hours | Full Marks: 25

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.
All symbols are of usual significance.

Answer any *one* question from the following 25×1=25

1. (a) Find out whether $\psi = \cos x$ is well-behaved or not. 2
   (b) Why pure vibrational transition without affecting rotation is not permitted? 2
   (c) What are the differences between hot band and overtone in IR spectroscopy? 2
   (d) What are Stokes and Anti-Stokes lines in Raman Spectroscopy? 2
   (e) What are the main characteristics of an anharmonic oscillator? 2
   (f) What are the advantages of Raman Spectroscopy over Infra-red Spectroscopy? 3
   (g) As the number of nodes increases, the energy of the system also increases — Explain. 2
   (h) A particle of mass, *m*, is in a 3*D* cube with sides *L*. It is in third excited state, corresponding to $n^2 = 11$. Calculate the possible combinations of n_1, n_2 and n_3. 2
   (i) What are P, Q, R branches in vibrational-rotational spectroscopy? 2
   (j) The distinguish between fluorescence and phosphorescence. 3
   (k) State and explain Lambert-Beer law. What is the significance of molar extinction coefficient? 2+1

2. (a) Verify that $\psi = \sin ax$ [where a is a constant] is not an eigen function of $\frac{d}{dx}$. Modify the operator so that the said function will be an eigen function. Find out the eigen value. 3
   (b) What do you mean by 'infrared active' and 'microwave active' molecules in spectroscopy? Give examples. 2
   (c) Show that the de Broglie's hypothesis leads to Bohr's postulate of quantisation of angular momentum. 2
   (d) Set up the Schrodinger equation for a particle in a one-dimensional box. Show that the solution of this equation leads to the quantization of translational motion. Why a value of quantum number $n = 0$ is not permitted? 2+3+1
   (e) State and explain the laws of photochemistry. Define quantum yield. 2+2
   (f) What is Raman spectroscopy? What is the quantum mechanical explanation of Raman effect? 1+2
   (g) Calculate the energy (in eV) of an Einstein of radiation of wave length 300 nm. 2
   (h) The fundamental vibrational frequency of HCl is 2590 cm^{-1}. Calculate the force constant of HCl molecule. 3

——×——

COOCH BEHAR PANCHANAN BARMA UNIVERSITY

B.Sc. Honours 6th Semester Examination, 2021

PHYSICS

EXPERIMENTAL TECHNIQUES

DSE-3

Time Allotted: 2 Hours | Full Marks: 25

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.
All symbols are of usual significance.

Answer any *one* question from the following 25×1=25

1. (a) Write short notes on Pirani gauge and Ionization gauge with schematic diagrams for the measurement of pressure. 20+5 = 25

   (b) A capacitor of value $(1.0 \pm 0.1)\,\mu F$ is charged to a voltage of $(20 \pm 1)\,V$, where the errors are standard deviations. Find the charge on the capacitor and its standard deviation.

2. (a) Explain the operation of a Q-meter for measurement of capacitance. 10+15 =25

   (b) Explain the construction, working principle, advantages and applications of linear variable differential transformer (LVDT).

——×——

COOCH BEHAR PANCHANAN BARMA UNIVERSITY

B.Sc. Honours 6th Semester Examination, 2021

MATHEMATICS

NUMBER THEORY

DSE-3

Time Allotted: 2 Hours | Full Marks: 40

The figures in the margin indicate full marks.
All symbols are of usual significance.

Answer any *two* from the following questions 20×2 = 40

1. (a) If m be a positive integer and a is prime to m, then show that $a^{\phi(m)} \equiv 1 \pmod{m}$. 10

   (b) If p and $2p+1$ are both odd prime and $n = 4p$, then show that $\phi(n+2) = \phi(n)+2$. 10

2. (a) Prove that product of any three consecutive integers is divisible by 6. 10

   (b) State and prove Chinese remainder theorem. 10

3. (a) Find the general solution in integers of the equation $5x+12y=80$ and examine if there is a solution in positive integers. 10

   (b) Show that the integer 2^k has no primitive root for $k \geq 3$. 10

——×——

COOCH BEHAR PANCHANAN BARMA UNIVERSITY

B.Sc. Honours 6th Semester Examination, 2021

CHEMISTRY

POLYMER CHEMISTRY

DSE-3

Time Allotted: 2 Hours | Full Marks: 25

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.
All symbols are of usual significance.

Answer any *one* question from the following 25×1 = 25

1. (a) Write down the preparation, structure, properties and uses of polycarbonate. 5

   (b) What is coordination polymerization? Give an example with detailed mechanism. 5

   (c) Average is essential to assign molar mass of a polymer. — Explain. 2

   (d) Discuss in brief the modes of formation of polymers. 5

   (e) What is coordination polymerization? Give an example with detailed mechanism. 5

   (f) Consider a polymer, which contains four molecular weight polymeric units in different numbers and weight. Calculate the number average molecular weight for the same. 3

Polymer entity	Number of units in each entity, n	Molecular weight of each grams, M (g)
Poly-1	2	10000
Poly-2	4	15000
Ploy-3	6	20000
Poly-4	5	25000

2. (a) What are semi-synthetic polymers? Give two examples. 2

   (b) Derive the integrated rate equation for a condensation reaction when a mineral acid is used as a catalyst. 5

   (c) What is Carother's equation? How is it important in polymer chemistry? 3

   (d) Depict a free radical mode of addition polymerization for isoprene. 4

   (e) Deduce the relationship between average functionality, extent of reaction and degree of polymerization. 4

   (f) What do you mean by co-polymers? Why does styrene undergo anionic polymerization easily? 3

   (g) A polymer contains two equal number of particle with molecular weight 15,000 g mol^{-1} and 25000 g mol^{-1}. Calculate the number average and weight average molecular weight of the polymer. 4

——×——

COOCH BEHAR PANCHANAN BARMA UNIVERSITY

B.Sc. Honours 6th Semester Examination, 2021

PHYSICS

NUCLEAR AND PARTICLE PHYSICS

DSE-4

Time Allotted: 2 Hours | Full Marks: 40

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.
All symbols are of usual significance.

Answer any *two* questions from the following 20×2 = 40

1. Given the following information for several light nuclei (1 amu = 931.5 MeV)

Nuclide	${}_0^1n$	${}_1^1H$	${}_1^2H$	${}_1^3H$	${}_2^4He$	${}_3^7Li$	${}_5^{10}B$
Nuclide mass (amu)	1.00866	1.00783	2.01410	3.01605	4.02719	7.01600	10.01294

(a) What is the maximum-energy of the β-particle emitted when ${}_1^3H$ decays to ${}_2^3H$? 10

(b) Obtain the *Q*-values for the following two nuclear reactions:

(i) ${}_3^7Li + {}_2^4He \rightarrow {}_5^{10}B + {}_0^1n$ 5

(ii) ${}_1^2H + {}_1^2H \rightarrow {}_1^3H + {}_1^1H$ 5

2. Describe the principle and basic design of cyclotron accelerators. 20

3. Describe nuclear beta decay. How Pauli rescued the spin conservation in nuclear beta decay with his neutrino hypothesis? 20

——×——

COOCH BEHAR PANCHANAN BARMA UNIVERSITY

B.Sc. Honours 6th Semester Examination, 2021

MATHEMATICS

BOOLEAN ALGEBRA & DISCRETE MATHEMATICS

DSE-4

Time Allotted: 2 Hours | Full Marks: 40

The figures in the margin indicate full marks.
All symbols are of usual significance.

Answer any *two* questions 20×2 = 40

1. (a) Find the CNF of the following Boolean Function 10

$$f(x, y, z) = xyz + (x + y)(y + z)$$

(b) Solve the recurrence relation $a_{n+2} - 6a_{n+1} + 9a_n = 3(2^n) + 7(3^n)$ with the initial conditions $a_0 = 1,\ a_1 = 4$. 10

2. (a) Show that the intersection of two sublattices is a sublattice. Is the union of any two sublattices also a sublattice? Give reason for your answer. 10

(b) Find the number of mathematics students at a college taking atleast one of the languages French, German and Russian, given the following data: 10

65 study French, 20 study French and German

45 study German, 25 study French and Russian

42 study Russian, 15 study German and Russian,

8 study all three languages.

3. (a) Find the prime implicants and a minimal sum-of-products form for the following complete sum-of-product Boolean expression: 10

$$E = xyz + xyz' + x'yz' + x'y'z$$

(b) Draw a logic circuit with inputs *A*, *B*, *C* and output *Y* which corresponds to the Boolean expression: 10

$$Y = ABC + A'C' + B'C'$$

——×——

COOCH BEHAR PANCHANAN BARMA UNIVERSITY

B.Sc. Honours 6th Semester Examination, 2021

CHEMISTRY

GREEN CHEMISTRY

DSE-4

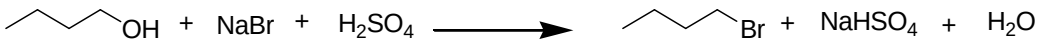
Time Allotted: 2 Hours | Full Marks: 25

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.
All symbols are of usual significance.

Answer any *one* question from the following 25×1 = 25

1. (a) Why do we need green chemistry as a regular practice in our chemical laboratory? What are the limitations or obstacles in the pursuits of the goals of Green Chemistry? 2+3

   (b) How would you design an organic reaction according to the most fundamental green chemistry principle the "atom economy"? Calculate the atom economy for the following substitution reaction, where 1-Bromobutane is the desired product. 2+3

   (c) What is supercritical CO_2? Mention the uses of $ScCO_2$ as a green solvent in different organic reactions with examples. 1+4

   (d) What are the advantages of microwave heating over conventional heating in organic synthesis? Give one example for each of the following microwave-assisted reactions in water: 2+3

   (i) Hofmann elimination

   (ii) Oxidation of toluene.

   (e) What are biocatalysts? What are the advantages of biocatalysts? Give one example for each of the bio-catalyzed oxidation and reduction reactions. 1+2+2

2. (a) What do you mean by "on water" and "in water" reaction? 2

   (b) What is ionic liquid? Why ionic liquid can replace the conventional solvents? Write a general method for the preparation of ionic liquid. 2+6+3

   (c) Outline the green synthesis of adipic acid using bio-resources. 2

   (d) What are sonochemical reactions? Explain the use of ultrasound in different organic reactions. 1+4

   (e) What are rightfit pigments? Write the name and the structure of two rightfit pigments. Write the advantages of rightfit pigments over inorganic and toxic pigments. 1+2+2

——×——