Total No. of Printed Pages—4

5 SEM TDC PHYH (CBCS) C 11

2022

(Nov/Dec)

PHYSICS

(Core)

Paper : C–11

(Quantum Mechanics and Applications)

Full Marks : 53

Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct answer from the following : 1×5=5

(a) Planck constant has the dimensions of

(i) force

(ii) energy

(iii) action

(iv) linear momentum

(b) The momentum space wave functions are the Fourier transforms of

(i) expectation value of momentum

(ii) position space wave functions

(iii) momentum eigenvalues

(iv) energy eigenfunctions

(c) The energy of a one-dimensional harmonic oscillator in first excited state is

(i) infinite (ii) zero

(iii) $\frac{3}{2}\hbar\omega$ (iv) $\frac{1}{2}\hbar\omega$

(d) The value of spin angular momentum for a one-electron atom is

(i) $\frac{1}{2}\hbar\omega$ (ii) $\frac{\sqrt{3}}{2}\hbar\omega$

(iii) $\hbar$ (iv) $-\frac{\hbar}{2}$

(e) The value of Lande's g-factor for an s-electron is

(i) 0 (ii) ½

(iii) 1 (iv) 2

2. Answer the following questions : 2×6=12

(a) What are the conditions for a wave-function to be physically acceptable?

(b) Define wave packet. With what velocity does a wave packet move?

(c) Briefly describe the relation between zero point energy and uncertainty principle of a Harmonic oscillator.

(d) What is Larmor precession? Define Bohr magneton.

(e) Briefly discuss the fine structure in sodium atom.

(f) State the basic differences between Paschen-Back and Stark effect.

3. (a) Prove the commutation relation $[x, p_x] = i\hbar$ 3

(b) Write down the wavefunction for ground state (Ψ_{100}) of a hydrogen atom. Show diagrammatically the polar representation of probability densities for s, p and d shells. 1+2=3

(c) What are orbital quantum number and magnetic quantum number? Write down the values of these quantum numbers for s, p and d shell. 2+2=4

4. *(a)* What are momentum space wave functions? Show that momentum space wave function is Fourier transform of the position space wavefunction. 1+6=7

Or

Obtain an expression for the wavefunction of a Gaussian wave packet. Briefly explain the spread of a Gaussian wave packet. 5+2=7

(b) Obtain an expression for the energy of a simple harmonic oscillator using Frobenius method. 7

Or

Obtain the energy eigenvalues for a particle confined in a one dimensional square well potential. 7

5. *(a)* Show the L-S coupling for an electron in $4p\,4d$ configuration and determine the spectral terms. 5

(b) Distinguish between normal and anomalous Zeeman effect. Obtain an expression for the magnetic interaction energy for a single valence electron experiencing normal Zeeman effect. 7

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Total No. of Printed Pages—6

5 SEM TDC PHYH (CBCS) C 12

2022

(Nov/Dec)

PHYSICS

(Core)

Paper : C–12

(Solid-State Physics)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct option from the following : 1×5=5

(a) The effective number of atoms in the unit cell of hexagonal close-packed structure is

(i) 6

(ii) 8

(iii) 12

(iv) 9

(b) For solids, the optical and acoustic branches coincide and forbidden band vanishes at $k = \pm \frac{\pi}{2a}$, when (mass of light and heavy atoms are m and M respectively)

(i) $m < M$

(ii) $m > M$

(iii) $m = M$

(iv) $mM = 1$

(c) The ferromagnetic susceptibility is given by

(i) $\chi = \frac{C}{T + T_c}$

(ii) $\chi = \frac{CT}{T + T_c}$

(iii) $\chi = C(T + T_c)$

(iv) $\chi = \frac{C}{T - T_c}$

(d) In a dipolar dielectric, in absence of an electric field, the dipoles are

(i) antiparallel

(ii) parallel

(iii) randomly oriented

(iv) None of the above

(e) The temperature coefficient of resistance of a pure semiconductor is

(i) negative

(ii) positive

(iii) zero

(iv) None of the above

2. Answer any *five* from the following questions : 2×5=10

(a) Define unit cell. If a unit cell has the following characteristics

$a = b = 10$ Å, $c = 7$ Å and $\alpha = \beta = \gamma = 90°$

identify to which crystal system does the unit cell belong.

(b) Define geometrical structure factor. How is it related to atomic scattering factor?

(c) State Dulong and Petit law of specific heat of solid.

(d) What is optical absorption and infrared absorption in a dielectric?

(e) What is piezoelectricity? Give an example of a crystal that is piezoelectric but not ferroelectric.

(f) What is Hall effect? What important conclusion can be drawn from the Hall effect?

3. (a) Obtain the Miller indices of a plane which intercepts at a, $\frac{b}{3}$ and $2c$ in a simple cubic unit cell. 2

(b) Prove that the packing fractions for a simple cubic (SC) structure and for a body-centred cubic (b.c.c.) structure are 0·52 and 0·74 respectively. 3

Or

Calculate the separation between lattice planes in a simple cubic, face-centred cubic (f.c.c.) and body-centred cubic (b.c.c.) lattice.

(c) Derive Bragg's law of crystal diffraction. Give its significance. 2+1=3

(d) Discuss the Debye model of lattice heat capacity. What is Debye T^3 law? 4+1=5

4. (a) Obtain an expression for diamagnetic susceptibility using the Langevin's theory. What is the significance of negative susceptibility? 4+1=5

Or

What is ferromagnetism? Discuss the Weiss field theory of ferromagnetism. Discuss how magnetic susceptibility varies with temperature. 5

(b) Obtain an expression for dipolar polarizability at moderate temperature. 4

(c) Classify ferroelectric materials into different groups on the basis of symmetry. Give one example of each group. 4

5. (a) Discuss briefly the Kronig-Penney model for motion of electron in a crystal and its important conclusion. 4

(b) The intrinsic carrier concentration in a Si sample is $1 \cdot 5 \times 10^{16}$ atoms/m^3. It is doped with 10^{23} phosphorus atoms/m^3. Determine its hole concentration and conductivity. Given electron mobility = $0 \cdot 135\ m^2 V^{-1} s^{-1}$. 3

Or

What do you mean by mobility? Derive the expression for conductivity of intrinsic semiconductor. 1+2=3

6. (a) Explain soft and hard superconductors. 3

(b) What is penetration depth for a superconductor? What is its value at the critical temperature? 1+1=2

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Total No. of Printed Pages—7

5 SEM TDC CHMH (CBCS) C 11

2022

(Nov/Dec)

CHEMISTRY

(Core)

Paper : C–11

(Organic Chemistry)

Full Marks : 53

Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct answer : 1×4=4

(a) Which of the following sets of bases is present both in DNA and RNA?

(i) Adenine, uracil, thymine

(ii) Adenine, guanine, cytosine

(iii) Adenine, guanine, uracil

(iv) Adenine, guanine, thymine

(b) The sequence of bases in DNA is TGAACCCTT, then the sequence of bases in m-RNA is

(i) ACUUGGGAA

(ii) TCUUGGGTT

(iii) ACUUCCCAA

(iv) None of the above

(c) The triglycerides of which of the following saturated fatty acids are not present in oils and fats?

(i) Palmitic acid

(ii) Stearic acid

(iii) Myristic acid

(iv) Acetic acid

(d) Which of the following statements best describes a synthon?

(i) A synthetic reagent used in a reaction

(ii) A key intermediate in a reaction sequence

(iii) A transition state involved in a reaction mechanism

(iv) A hypothetical structure that would result in a given reaction if it existed

(Continued)

UNIT—I

2. (a) Write the name and structure of the bases that are present only in DNA and RNA. 2

Or

Synthesize any one important purine base present in DNA.

(b) Show the complementary base pairing in DNA by a suitable diagram. 2

(c) Write a short note on transcription with proper diagram. 3

Or

Explain the secondary structure of DNA.

UNIT—II

3. (a) How can you determine the C-terminal and N-terminal residue of a peptide chain? 2

(b) Synthesize glycine with the help of Gabriel's phthalimide reaction. 2

(c) Write the name and structure of the compounds that are used to protect the amino group and to activate the —COOH group of amino acid during peptide synthesis. 2

(Turn Over)

(d) Write a short note on denaturation of protein with examples. 2

UNIT—III

4. (a) Define enzyme. Name an enzyme that digests fat. 1+1=2

Or

Discuss the Lock and Key model of enzyme action. 2

(b) What do you mean by inhibitors? Describe the competitive and non-competitive inhibitors. 1+2=3

(c) What are coenzymes? Discuss the role of NAD and FAD coenzymes. 3

UNIT—IV

5. (a) What are fats and oils? What is the importance of hydrogenation and hydrolysis of fats and oils? Explain with examples. 1+1=2

(b) Define acid value. What does it indicate? 1+1=2

Or

What is iodine value? What is its significance? 2

(c) Define soap. Give one example each of simple glycerides and mixed glycerides. 1+1=2

(d) Give a brief account of detergent and their washing action. 2

UNIT—V

6. (a) Write the synthetic equivalents of the following synthons (any *two*) : 2

(i) $\overset{\ominus}{C}H_3$

(ii) $\overset{\ominus}{C}H_2COOH$

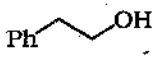
(iii) $\overset{\oplus}{C}H_2CH_2OH$

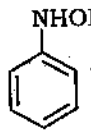
(iv) $H_3C-\overset{O}{\overset{\|}{C}}\overset{\ominus}{O}$

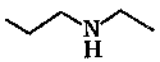
(b) What do you mean by FGI? Give an example. 2

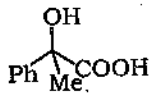
(c) With the help of the retrosynthetic analysis, write down the synthesis of the following TMs (any *three*) : 2×3=6

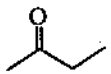
(i) 

(ii) 

(iii) 

(iv) 

(v) 

(vi) 

UNIT—VI

7. Answer any *four* of the following questions : 2×4=8

(a) Describe the synthesis of chloramphenicol.

(b) What are antibiotics and tranquilizers? Give one example in each case.

(c) Write in brief about the medicinal importance of curcumin present in haldi.

(d) Discuss the mode of action of sulphanilamides.

(e) What is antimalarial drug? Write the synthesis of an antimalarial drug.

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5 SEM TDC CHMH (CBCS) C 12

2022

(Nov/Dec)

CHEMISTRY

(Core)

Paper : C–12

(Physical Chemistry, Quantum Chemistry and Spectroscopy)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct answer from the following : 1×4=4

(a) The expression for Hamiltonian operator $\hat{H}$ is

(i) $\frac{h^2}{8\pi^2 m}\nabla^2 + V$

(ii) $-\frac{h^2}{8\pi^2 m} + V$

(iii) $\frac{h^2}{8\pi^2 m}\nabla^2 - V$

(iv) $-\frac{h^2}{8\pi^2 m}\nabla^2 - V$

(b) The eigenvalue of the function $\psi = 8e^{4x}$ is

(i) e^{4x}

(ii) 32

(iii) 8

(iv) 4

(c) The rotational spectrum of a rigid diatomic rotator consists of equally spaced lines with spacing equal to

(i) B

(ii) $2B$

(iii) $B/2$

(iv) $4B$

(d) Intersystem crossing refers to

(i) transition between two states of a system

(ii) radiationless transition between states of different spin multiplicities

(iii) transition between excited and ground states with same multiplicity

(iv) All of the above

(Continued)

2. Answer any *four* questions from the following : 2×4=8

(a) HBr molecule is microwave active. Explain, why.

(b) Describe Larmor frequency.

(c) Water is a good solvent for UV and visible spectroscopy, but not for IR spectroscopy. Explain.

(d) Distinguish photochemical reaction from thermal reaction.

(e) State whether the function

$$\psi = \sin(k_1 x)\sin(k_2 y)\sin(k_3 z)$$

is an eigenfunction of the operator ∇^2. If it is an eigenfunction, find eigenvalue.

UNIT—I

3. Answer any *four* questions from the following : 4×4=16

(a) Solve Schrödinger's wave equation for a particle having mass m moving freely in a one-dimensional box of length a. Find out the energy expression. 3+1=4

(Turn Over)

(b) What is a simple harmonic oscillator? Deduce an expression for the fundamental frequency of a harmonic oscillator. 1+3=4

(c) (i) What is an operator? Write quantum mechanical operator corresponding to momentum. 1+1=2

(ii) Examine if the function

$\psi_1(x) = N_1(a^2 - x^2)$ and $\psi_2(x) = N_2 x(a^2 - x^2)$

are orthogonal within $-a < x < a$. 2

(d) (i) Show that Hamiltonian operator ($\hat{H}$) for a rigid rotator is given by $\hat{H} = L^2/2I$, where L is the angular momentum and I is the moment of inertia. 2

(ii) Write the energy expression for second energy-level of a rigid rotator. 2

(e) (i) Write Schrödinger wave equation for hydrogen atom in Cartesian and polar coordinate. 1+1=2

(ii) What does the term 'degenerate level' mean? Calculate degeneracy of the level having energy $\frac{5h^2}{8ma^2}$ for a free particle moving in a two-dimensional box of two equal side lengths. 1+1=2

(f) (i) What is zero point energy? Calculate zero point energy of a molecule if it is considered as a simple harmonic oscillator. 2

(ii) Sketch and explain the wave functions for the first three energy levels for the particle in one-dimensional box. 2

UNIT—II

4. Answer any *four* questions from the following : 4×4=16

(a) Describe different types of electronic transitions with one example of each.

(b) State Frank-Condon principle. Explain the effects of change of solvents on $n \rightarrow \pi^*$ and $\pi \rightarrow \pi^*$ transitions. Write the significance of molar extinction coefficient. 1+2+1=4

(c) The C—H vibration (stretching) in chloroform occurs at 3000 cm^{-1}. Calculate the C—D frequency (stretching) in deutero chloroform. It is supposed force constants remain same during isotopic substitution.

(d) Write brief notes on the following : 2×2=4

(i) Chemical shift

(ii) Spin-spin coupling

(e) (i) Discuss the effect of isotopic substitution on the rotational spectra of a diatomic molecule. 2

(ii) Roughly sketch the fundamental vibrations of water molecule and show the infrared active vibrations. 2

UNIT—III

5. Answer any *two* questions from the following : 4½×2=9

(a) What is quantum yield of a photochemical reaction? Under what condition is its value 1? A certain system absorbs 3×10^{20} quanta of light per second. On irradiation for 20 minutes, 0·02 mole of the reactant was found to have reacted. Calculate the quantum yield of the reaction. 1+1+2½=4½

(b) What are photochemical reactions? Write the differences between photochemical and thermal reactions. Discuss the reasons for high and low quantum yields of photochemical reactions. ½+2+2=4½

(Continued)

(c) (i) Write a short note on any *one* of the following : 2

(1) Actinometry

(2) Chemiluminescence

(ii) Write the differences between phosphorescence and fluorescence. 2½

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Total No. of Printed Pages—3

5 SEM TDC ZOOH (CBCS) C 11

2022

(Nov/Dec)

ZOOLOGY

(Core)

Paper : C–11

(Molecular Biology)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Fill in the blanks : 1×5=5

(a) In phi (ϕ)×174 phage, the DNA is _____.

(b) _____ protein prevents the reannealing of DNA strands.

(c) Enzyme required for removing RNA primer during DNA replication is _____.

(d) During protein synthesis, tRNAs are not involved in _____.

(e) _____ operon is an example of repressible operon system.

2. Explain precisely the following : 4×2=8

(a) Pyrimidine dimerization

(b) Riboswitches or RNA interference

3. Write explanatory notes on the following : 4×2=8

(a) Watson and Crick model

(b) RNA editing or split gene

4. Draw and describe the structure of replication fork. Briefly explain the bidirectional nature of DNA replication. 4+4=8

Or

What is RNA primer? Describe the various enzymes involved in DNA replication. 2+6=8

5. Explain the process of transcription in prokaryotes using suitable illustration. 6+2=8

Or

Describe the promoter sites for initiation of transcription in prokaryotes and eukaryotes. 4+4=8

6. What is genetic code? Why are codons triplet? Write a note on degeneracy of genetic code. 2+3+3=8

Or

Explain the process of translation in prokaryotes using suitable illustration. 8

7. What is repressor? Write a note about transcriptional regulation in lac operon. 2+6=8

Or

What is inducible and repressible operon? Explain how does an excess of tryptophan causes switching off of tryptophan operon. 4+4=8

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Total No. of Printed Pages—3

5 SEM TDC ZOOH (CBCS) C 12

2022

(Nov/Dec)

ZOOLOGY

(Core)

Paper : C–12

(Principles of Genetics)

Full Marks : 53

Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Fill in the blanks : 1×5=5

(a) Inheritance of Y-linked genes is called _____.

(b) Chromosomal theory of linkage is proposed by _____.

(c) Klinefelter's syndrome is a type of _____ disorder.

(d) The F_2 ratio in polygenic inheritance is _____.

(e) The transposing elements in *Drosophila* are known as _____ elements.

2. Write briefly on any *two* of the following : 3×2=6

(a) Epistasis

(b) Codominance

(c) Incomplete dominance

3. What is crossing-over? Write briefly about cytological basis of crossing-over. 2+5=7

Or

Define linkage. Explain it with a suitable example. 7

4. What is chromosomal aberration? Explain any two forms of chromosomal anomalies in human. 2+5=7

Or

What are mutagens? Give examples of some mutagens. Explain briefly the methods of detection of mutation. 2+2+3=7

5. Explain the mechanism of sex determination in man. 7

6. What do you mean by extrachromosomal inheritance? Write about antibiotic resistance in *Chlamydomonas.* 3+4=7

7. What is polygenic inheritance? Distinguish between transformation and transduction. 3+4=7

8. What is transposon? Write about A_c-D_s elements in maize or P elements in *Drosophila.* 2+5=7

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Total No. of Printed Pages—3

5 SEM TDC DSE ZOO (CBCS) 3 (H)

2022

(Nov/Dec)

ZOOLOGY

(Discipline Specific Elective)

(For Honours)

Paper : DSE–3

(Endocrinology)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Fill in the blanks : 1×5=5

(a) _____ cells secrete testosterone hormone.

(b) Melatonin is secreted by _____ gland.

(c) _____ is a hormonal disorder resulting from the production of too much growth hormone by pituitary gland.

(d) Exophthalmic goiter is caused by overactivity of _____ gland.

(e) Cushing's syndrome occurs when there is an excess of the _____ hormone.

2. Write brief notes on any *four* of the following : 4×4=16

(a) Characteristics of hormone

(b) Hypothalamic nuclei and their functions

(c) Hypothalamo-hypophysial portal system

(d) Ultrastructure of pituitary gland

(e) Pineal secretion in biological rhythms

3. Write a note on the history of endocrinology. Add a note on neurohormones. 4+4=8

Or

What is hormone? Describe the classification of hormones. 2+6=8

4. Describe the histological structure of ovary with suitable diagram and write the endocrine functions. 5+3=8

Or

What do you mean by feedback mechanism? Write the physiological role of insulin and glucagon. 2+6=8

5. Draw the ultrastructure of parathyroid gland. Explain how calcium is being regulated with suitable illustration. 3+5=8

Or

Describe the structure and function of thyroid gland. 4+4=8

6. What are hormone receptors? Add a note on endocrine disorders. 2+6=8

Or

What do you mean by second messenger? Explain the mechanism of steroid hormone. 2+6=8

★★★

5 SEM TDC DSE ZOO (CBCS) 4 (H)

2022

(Nov/Dec)

ZOOLOGY

(Discipline Specific Elective)

(For Honours)

Paper : DSE–4

(Biology of Insecta)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Fill in the blanks : 1×5=5

(a) In locust, the major portion of digestion takes place in _____.

(b) _____ is found in Chironomus larvae as respiratory pigment.

(c) *Odontotermes obesus* is the scientific name of _____.

(d) The formation of spermatophores takes place in the _____ gland in cockroaches.

(e) Insects breathe through _____.

2. Write short notes on any *two* of the following : 3×2=6

(a) General features of insects

(b) Phytophagous insect

(c) Spiracles

3. Answer any *three* of the following questions : 4×3=12

(a) Write a brief note about the adaptations of insect legs in different habitats.

(b) Give an account of antennae of insects.

(c) Distinguish between Corpus cardiacum and Corpus allatum.

(d) Give an account on insect hormones.

4. What are the allelochemicals? Write briefly about the role of these chemicals in host plant mediation. 4+4=8

5. Give an account of the basis of classification of insects. 6

Or

Classify the class Insecta up to order with example.

6. Explain the respiratory or digestive system of insects with suitable labelled diagrams. 7

7. Discuss how mosquitoes and housefly act as important insect vectors. 9

Or

Write short notes on any *two* of the following : 4½×2=9

(a) Malpighian tubules

(b) Social organization in insect (any insect)

(c) Paddy pests

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Total No. of Printed Pages—3

5 SEM TDC BOTH (CBCS) C 11

2022

(Nov/Dec)

BOTANY

(Core)

Paper : C–11

(Reproductive Biology of Angiosperms)

Full Marks : 53

Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. *(a)* Choose the correct answer from the following : 1×3=3

(i) The edible part of litchi is pericarp/endosperm/aril.

(ii) The wall layer of microsporangium which provides nourishment to developing microspores is called anther wall/tapetum/exine.

(iii) The development of endosperm of arecanut is cellular/nuclear/helobial type.

(b) Fill in the blanks : 1×2=2

(i) The entry of the pollen grain into the ovule through the chalaza is called _____.

(ii) When the micropyle, chalaza and funicle of an ovule lie on one straight line, it is called _____.

2. Write precise notes on the following (any *three*) : 4×3=12

(a) Bisporic embryo sac

(b) Induction polyembryony

(c) Helobial endosperm

(d) Significance of pollination

(e) Induction of flowering

3. What do you mean by double fertilization? Write in detail about the process of double fertilization. Give diagram where necessary. 3+7+2=12

Or

Write explanatory notes on the following : 6+6=12

(a) Haustorial structures of endosperms

(b) Palynology and its significance

4. What do you mean by embryo-endosperm relationships? With illustration, write briefly on unusual development of embryo in *Paeonia*. 2+10=12

Or

Write notes on the following : 4×3=12

(a) Obturator

(b) Aril

(c) Caruncle

5. Write explanatory notes on the following : 6+6=12

(a) Megagametogenesis

(b) Methods to overcome self-incompatibility

Or

What is parthenocarpy? Write briefly on the causes and their application. 2+5+5=12

★★★

Total No. of Printed Pages—3

5 SEM TDC BOTH (CBCS) C 12

2022

(Nov/Dec)

BOTANY

(Core)

Paper : C–12

(Plant Physiology)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. *(a)* Choose the correct answer of the following : 1×3=3

(i) Casparian strips are found in epidermal cells/cortical cells/ pericycle/endodermal cells of roots of plants.

(ii) Cohesive force of water is due to presence of hydrogen bonds between water molecules/covalent bonds between water molecules/ hydrogen bonds between water and components of xylem walls/None of these.

(iii) Which of the following is supposed to be precursor of florigen? Auxin/ Gibberellin/Cytokinin/All of these.

(b) Fill in the blanks : 1×2=2

(i) Avena-Curvature test for bioassay was developed by _____.

(ii) Osmotic pressure of pure water is _____.

2. What is ascent of sap? Explain in detail the transpiration pull and cohesion of water theory of ascent of sap. Cite some evidences in support of this theory. 2+7+3=12

Or

What is Donnan's equilibrium? Describe the principles involved in the mechanism of absorption of mineral salts by plants. 3+9=12

3. What are the trace elements? Write the general functions of essential elements in plants. How will you determine the essentiality of a particular mineral element for the normal growth and development of the plants? 3+7+2=12

Or

Write explanatory notes on the following : 6+6=12

(a) Active absorption of water by plants

(b) High irradiance response (HIR)

4. Define tropic movement in plants. Explain with examples the different types of tropic movement in plants. 2+10=12

Or

Write briefly on the following : 4×3=12

(a) Vernalization

(b) Significance of osmosis

(c) Guttation

5. What are gibberellins? How are they synthesize in plants? Describe the role of gibberellins in plants. 2+5+5=12

Or

Write explanatory notes on the following : 6+6=12

(a) Role of phytochrome in photomorphogenesis

(b) Loading and unloading in phloem transport

★★★

5 SEM TDC DSE BOT (CBCS) 4 (H)

2022

(Nov/Dec)

BOTANY

(Discipline Specific Elective)

(For Honours)

Paper : DSE–4

(Industrial and Environmental Microbiology)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Answer very briefly : 1×5=5

(a) What is batch fermentation?

(b) Who discovered streptomycin?

(c) Define eutrophication.

(d) Name the organic acid used to prepare vinegar.

(e) Name one GMO used to reduce oil pollution.

2. Answer briefly : 2×4=8

(a) Mention about the use of acetic acid.

(b) What is lyophilization?

(c) What is the necessity of determination of BOD?

(d) Mention about the role of leghaemoglobin in nitrogen-fixing prokaryotes.

3. Write short notes on any *three* of the following : 3×3=9

(a) Ultrafiltration

(b) Solid-state fermentation

(c) Economic importance of Mycorrhizae

(d) Pilot scale fermentation

4. Answer any *three* of the following : 5×3=15

(a) Mention about the advantages of enzyme immobilization.

(b) Write about cellulose hydrolysis test for screening different types of microorganism.

(c) Write an account on different methods for isolation of microorganism from water.

(d) Describe some measures to control sewage pollution.

5. Describe about the role of microorganism as the indicator of water quality. 6

Or

Write a brief note on point and non-point sources of water pollution. 6

6. Explain about different stages for production of amylase. Mention some uses of amylase enzyme. 7+3=10

Or

With example, mention about the scope and uses of microbes in industry. 5+5=10

★★★

5 SEM TDC MTMH (CBCS) C 11

2022

(Nov/Dec)

MATHEMATICS

(Core)

Paper : C–11

(Multivariate Calculus)

Full Marks : 80
Pass Marks : 32

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. *(a)* Let partial derivatives of a function of two variables exist. Does it imply that the function is continuous? 1

(b) Find $\frac{\partial f}{\partial x}$, where $f(x, y) = e^{x^2 + xy}$. 1

(c) Show that

$$f(x,y) = \begin{cases} \dfrac{2xy}{x^2+y^2} & ; \ (x,y) \neq (0,0) \\ 0 & ; \ (x,y) = (0,0) \end{cases}$$

is continuous at every point, except the origin $(0,0)$. 3

Or

Using definition, show that the function

$$f(x,y)=\begin{cases}\dfrac{xy}{\sqrt{x^2+y^2}} & ; \ (x,y)\neq(0,0)\\ 0 & ; \ (x,y)=(0,0)\end{cases}$$

is continuous at the origin.

(d) Find

$$\frac{\partial^3 u}{\partial z\partial y\partial x} \text{ and } \frac{\partial^3 u}{\partial x^2\partial y}$$

if $u=\dfrac{x}{y+2z}$. 3

2. *(a)* Write True or False : 1

"If a function $f(x,y)$ is continuous at (x_0,y_0), then f is differentiable at (x_0,y_0)."

(b) Use chain rule to find the derivative of $w=xy$ with respect to t along the path $x=\cos t,\ y=\sin t$. 2

(c) Find the values of $\dfrac{\partial z}{\partial x}$ and $\dfrac{\partial z}{\partial y}$ at the point (π,π,π) for the function

$$\sin(x+y)+\sin(y+z)+\sin(x+z)=0$$ 4

Or

Find the derivative of $f(x,y,z)=x^3-xy^2-z$ at $\rho_0(1,1,0)$ in the direction of $\vec{v}=2\hat{i}-3\hat{j}+6\hat{k}$. In what direction does f increases most rapidly at ρ_0?

3. *(a)* Find the plane, tangent to the surface $z=x\cos y-ye^x$ at $(0,0,0)$. 2

(b) Find the local extreme values of

$$f(x,y)=3y^2-2y^3-3x^2+6xy$$ 3

(c) Find the points on the hyperbolic cylinder $x^2-z^2=1$ that are closest to the origin. 5

Or

Find the maximum and minimum values of the function $f(x,y)=3x+4y$ on the circle $x^2+y^2=1$.

4. *(a)* Define gradient vector of $f(x,y)$ at a point. 1

(b) Show that

$$\vec{f}(x,y,z)=(y^2z^3)\hat{i}+(2xyz^3)\hat{j}+(3xy^2z^2)\hat{k}$$

is a conservative vector field. 2

(c) Calculate the curl $\vec{f}$, where

$$\vec{f} = \frac{x\hat{i} + y\hat{j} + z\hat{k}}{\sqrt{x^2 + y^2 + z^2}}$$ 2

5. (a) State Fubini's theorem of first form. 1

(b) Evaluate

$$\iint_R f(x, y)\, dxdy \text{ for } f(x, y) = 1 - 6x^2y^2,$$

$R : 0 \le x \le 1$ and $-2 \le y \le 2$. 2

(c) Prove that

$$\iint_R e^{x^2 + y^2}\, dydx = \frac{\pi}{2}(e - 1)$$

where R is the semicircular region bounded by the x-axis and the curve $y = \sqrt{1 - x^2}$. 3

6. (a) Define volume of a region in space. 2

(b) Find $\int_0^2 \int_0^2 \int_0^2 xyz\, dxdydz$. 2

(c) Find the volume of the region D enclosed by the surfaces $z = x^2 + 3y^2$ and $z = 8 - x^2 - y^2$. 5

Or

Evaluate the following integral by changing the order of the integration in an appropriate way :

$$\int_0^4 \int_0^1 \int_{2y}^2 \frac{4\cos(x^2)}{2\sqrt{z}}\, dx\, dy\, dz$$

7. (a) Write the formula for triple integral in spherical coordinates. 1

(b) Evaluate : 4

$$\int_0^{\pi} \int_0^1 \int_0^{\sqrt{3 - r^2}} dzrdrd\theta$$

Or

Find a spherical coordinate equation for the sphere $x^2 + y^2 + (z - 1)^2 = 1$.

8. (a) Define Jacobian of a function of two variables. 1

(b) Evaluate : 3

$$\iint_{x^2 + y^2 \le a^2} (x^2 + y^2)\, dx\, dy$$

(c) Find the value of

$$\int_C \{(x+y^2)\,dx + (x^2 - y)\,dy\}$$

taken in the clockwise sense along the closed curve C formed by $y^3 = x^2$ and the chord joining $(0,0)$ and $(1,1)$. 3

Or

Evaluate $\int_C (xy + y + z)\,ds$ along the curve $\vec{r}(t) = 2t\hat{i} + t\hat{j} + (2-2t)\hat{k}$, $0 \le t \le 1$.

9. (a) Define line integrals of a vector field. 1

(b) Find the circulation of the field $\vec{F} = (x-y)\hat{i} + x\hat{j}$ around the circle $\vec{r}(t) = (\cos t)\hat{i} + (\sin t)\hat{j}$, $0 \le t \le 2\pi$. 3

(c) State and prove the fundamental theorem of line integrals. 4

Or

A fluid's velocity field is $\vec{F} = x\hat{i} + z\hat{j} + y\hat{k}$. Find the flow along the helix $\vec{r}(t) = (\cos t)\hat{i} + (\sin t)\hat{j} + t\hat{k}$, $0 \le t \le \frac{\pi}{2}$.

10. (a) Define Green's theorem in Tangential form. 1

(b) Evaluate

$$\oint_C (y^2\,dx + x^2\,dy)$$

using Green's theorem, where C is the triangle bounded by $x = 0$, $x + y = 1$, $y = 0$. 3

(c) State and prove Stoke's theorem. 6

Or

Evaluate $\int_C \vec{F} \cdot d\vec{r}$ by using Stoke's theorem, if $\vec{F} = x^2\hat{i} + 2x\hat{j} + z^2\hat{k}$ and C is the ellipse $4x^2 + y^2 = 4$ in the xy plane, counterclockwise when viewed from above.

(d) Use Divergence theorem to find the outward flux of $\vec{F}$ across the boundary of the region D, where

$$\vec{F} = (y-x)\hat{i} + (z-y)\hat{j} + (y-x)\hat{k}$$

and D is the cube bounded by the planes $x = \pm 1$, $y = \pm 1$ and $z = \pm 1$. 5

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Total No. of Printed Pages—5

5 SEM TDC MTMH (CBCS) C 12

2022

(Nov/Dec)

MATHEMATICS

(Core)

Paper : C–12

(Group Theory—II)

Full Marks : 80

Pass Marks : 32

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. *(a)* Choose the correct answer for the following question : 1

An automorphism is

(i) a homomorphism but not one-one

(ii) a homomorphism, one-one but not onto

(iii) one-one, onto but not homomorphism

(iv) a homomorphism, one-one and onto

(b) Show that a characteristic subgroup of a group G is a normal subgroup of G. Is the converse true? 2+2=4

(c) Let G' be the commutator subgroup of a group G, then prove that G is abelian if and only if $G' = \{e\}$. 3

(d) If N is a normal subgroup of a group G, G' is the commutator subgroup of G and $N \cap G' = \{e\}$, then show that $N \subseteq Z(G)$. 3

(e) Show that, if $O(\text{Aut}\,G) > 1$ then $O(G) > 2$. 3

(f) Show that the set $I(G)$ of all inner automorphism of a group G is a subgroup of Aut G. 4

2. Answer any *two* of the following : 6×2=12

(a) Let $I(G)$ be the set of all inner automorphisms on a group G, then prove that

$$I(G) \approx \frac{G}{Z(G)}$$

(b) Prove that for every positive integer n, Aut (Z_n) is isomorphic to $U(n)$.

(c) Let $R^n = \{(a_1, a_2, ..., a_n) \mid a_i \in R\}$. Show that the mapping

$$\phi: (a_1, a_2, ..., a_n) \to (-a_1, -a_2, ..., -a_n)$$

is an automorphism of the group R^n under component wise addition.

3. (a) Find the order of the element (1, 1) in $Z_{100} \oplus Z_{25}$. 2

(b) Show that a group of order 4 is either cyclic or is an internal direct product of two cyclic groups of order 2 each. 3

(c) Let G and H be finite cyclic groups. Prove that $G \oplus H$ is cyclic if and only if $|G|$ and $|H|$ are relatively prime. 4

(d) If s and t are relatively prime, then prove that

$$U(st) \approx U(s) \oplus U(t)$$ 5

Or

How many elements of order 5 does $Z_{25} \oplus Z_5$ have?

(e) If a group G is the internal direct product of a finite number of subgroups $H_1, H_2, ..., H_n$, then prove that G is isomorphic to the external direct product of $H_1, H_2, ..., H_n$. 6

Or

Let G be a finite abelian group of order $p^n m$, where p is a prime that does not divide m then prove that $G = H \times K$, where $H = \{x \in G | x^{p^n} = e\}$ and $K = \{x \in G | x^m = e\}$.

4. *(a)* Define conjugate class of a. 1

(b) If $|G| = p^2$, where p is a prime, then prove that G is abelian. 3

(c) Let G be a finite group and let a be an element of G, then prove that

$$|Cl(a)| = |G : C(a)|$$ 3

(d) Prove that a group of order 80 has a non-trivial normal Sylow p-subgroup. 3

(e) Let G be a group. Prove that $Cl(a) = \{a\}$, if and only if $a \in Z(G)$. 4

(f) Prove that no group of order 56 is simple. 5

Or

Prove that a Sylow p-subgroup of a group G is normal if and only if it is the only Sylow p-subgroup of G.

(g) If G is a group of order pq, where p and q are primes, $p < q$, and p does not divide $q - 1$, then prove that G is cyclic. 5

(h) Prove that any two Sylow p-subgroups of a finite group G are conjugate in G. 6

Or

Prove that an integer of the form $2 \cdot n$, where n is an odd number greater than 1, is not the order of a simple group.

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Total No. of Printed Pages—20

5 SEM TDC DSE MTH (CBCS)
1.1/1.2/1.3 (H)

2022

(Nov/Dec)

MATHEMATICS

(Discipline Specific Elective)

(For Honours)

Paper : DSE–1

Full Marks : 80
Pass Marks : 32

Time : 3 hours

The figures in the margin indicate full marks for the questions

Paper : DSE–1.1

(Analytical Geometry)

1. Answer the following questions :

(a) Write the vertex of the conic

$$(x-1)^2 = 2(y+2)$$ 1

(b) Find the equation of the ellipse whose ends of major axis (0, ±6), and passes through the point (–3, 2). 4

(c) Write the processes to sketch the ellipse. 4

(d) Identify and sketch the curve

$$y^2 - 8x - 6y - 23 = 0$$

and also label the focus, vertex and directrix. 6

Or

Describe the graph of the hyperbola

$$16x^2 - y^2 - 32x - 6y - 57 = 0$$

and sketch its graph.

2. Answer the following questions :

(a) Write the condition of tangency of the line $y = mx + c$ to the parabola $y^2 = 4ax$. 1

(b) Write the reflection property of ellipse. 1

(c) Write the equation of the asymptotes of the hyperbola $\frac{x^2}{4} - \frac{y^2}{9} = 1$. 1

(d) Derive the equation of tangent to the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ at the point (x_1, y_1). 6

(Continued)

(e) Find the equation of the hyperbola whose length of transverse axis 7 units and foci (±5, 0) and also sketch it. 6

Or

Find and sketch the curve of the ellipse whose foci (1, 2) and (–1, –2) and the sum of the distances from each point $P(x, y)$ on the ellipse is 6 units.

3. Answer the following questions :

(a) Write the condition that the equation

$$ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$$

represent a pair of straight lines. 1

(b) Write the condition that the quadratic equation

$$Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$$

represents an ellipse. 1

(c) Determine a rotation angle θ that will eliminate the xy-term of the conic

$$x^2 - 4xy + 4y^2 - 5 = 0$$ 2

(Turn Over)

(d) Show that the graph of the given equation

$$x^2 - 10\sqrt{3}xy + 11y^2 + 64 = 0$$

is a hyperbola. Find its foci, vertices and asymptotes. 5

(e) Let an $x'y'$-coordinate system be obtained by rotating an xy-coordinate system through an angle $\theta = 60°$.

(i) Find the $x'y'$-coordinate of the point whose xy-coordinate is $(-2, 6)$.

(ii) Find an equation of the curve $\sqrt{3}xy + y^2 = 6$ in $x'y'$-coordinate. 6

Or

Identify and sketch the curve

$$9x^2 - 24xy + 16y^2 - 80x - 60y + 100 = 0$$

4. Answer the following questions :

(a) Write the equation of a sphere whose centre is at the origin and radius is r. 1

(b) Write True or False : 1

Curve of intersection of two spheres is a sphere.

(c) Write the standard equation of hyperbola of one sheet. 1

(d) Write the equation of the tangent plane to the sphere

$$x^2 + y^2 + z^2 + 2ux + 2vy + 2wz + d = 0$$

at $P(x_1, y_1, z_1)$. 2

(e) Find the equation of the sphere passes through the points $(0, 0, 0)$, $(0, 1, -1)$, $(-1, 2, 0)$, $(1, 2, 3)$. 5

(f) A sphere of constant radius k passes through the origin and meets axes in A, B and C. Prove that the centroid of the triangle ABC lies on the sphere

$$9(x^2 + y^2 + z^2) = 4k^2$$ 5

Or

Find the equation of the sphere whose centre at $(1, 2, 3)$ and touching a plane at $(2, 1, 3)$.

5. Answer the following questions :

(a) Find the radius and centre of the circle

$$x^2 + y^2 + z^2 - 8x + 4y + 8z - 45 = 0,\ x - 2y + 2z = 3$$

5

(b) Find the equation of the sphere whose great circle is

$$x^2+y^2+z^2+10y-4z-8=0,\ x+y+z=3$$ 5

Or

Prove that the two spheres

$$x^2+y^2+z^2-2x+4y-4z=0$$

and $$x^2+y^2+z^2+10x+2z+10=0$$

touch each other.

6. Answer the following questions :

(a) Find the equation of the two tangent planes to the sphere

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

which are parallel to the plane

$$2x+2y-z=0$$ 5

(b) Classify and sketch the quadric surface (any *one*) : 5

(i) $36x^2+9y^2+16z^2=144$

(ii) $4x^2-3y^2+12z^2+12=0$

Paper : DSE–1.2

(Portfolio Optimization)

1. Answer any *five* of the following questions : 1×5=5

(a) Why do individuals invest?

(b) Write the formula for holding period return (HPR).

(c) What is business risk?

(d) What is security market line (SML)?

(e) What is mutual fund?

(f) Define diversification.

2. (a) If a person invests ₹200 at the beginning of the year and get back ₹220 at the end of the year, find the holding period return (HPR) and holding period yield (HPY) of the investment. 2+2=4

(b) Write two measures of mean historical returns. Calculate the arithmetic mean (AM) of annual holding yields of the investment : 1+2=3

Year	*Beginning Value*	*Ending Value*	*HPY*
1	100·0	115·0	0·15
2	115·0	138·0	0·20
3	138·0	110·4	−0·20

(c) Calculate the risk in terms of variance and standard deviation of the investment in the following scenario : 3+2=5

Economic Condition	*Probability*	*Rate of Return*
Strong economy	0·15	0·20
Weak economy	0·15	– 0·20
No major change in economy	0·70	0·10

(d) Discuss the following five risks : 5

(i) Business risk

(ii) Financial risk

(iii) Liquidity risk

(iv) Exchange rate risk

(v) Country risk of an investment

(e) Define risk premium and systematic risk. 2+2=4

(f) Write three ways to change the relationship between risk and the required rate of return for an investment. 4

Or

Write a short note on investment objective and investment constraints.

3. (a) Write two assumptions of the Markowitz's portfolio theory. 2

(b) Find the variance and standard deviation of the following investment scenario : 4

Possible Rate of Return (R_i)	*Expected Security Return* $E(R_j)$	*Probabilities* (P_j)
0·08	0·103	0·35
0·10	0·103	0·30
0·12	0·103	0·20
0·14	0·103	0·15

(c) Find the covariance of rates of returns of US stocks and US bonds as given below :

2010	*US Stock Index* (R_i)	*US Bond Index* (R_j)
January	– 3·60	1·58
February	3·10	0·40
March	6·03	– 0·85
April	1·58	1·05
May	– 7·99	1·71
June	– 5·24	1·87
July	7·01	0·68
August	– 4·51	2·01
September	8·92	0·02
October	3·81	– 0·16
November	0·01	0·70
December	6·68	– 1·80

If standard deviations of both scenarios are $\sigma_i = 5{\cdot}56$ and $\sigma_j = 1{\cdot}22$, then find the correlation. 4+2=6

(d) State and prove two-fund theorem. 5

Or

Write the assumptions of Capital Market theory.

(e) State one-fund theorem. 2

(f) Write short notes on any *two* of the following : 3×2=6

(i) Optimal portfolio

(ii) Risk-free portfolio

(iii) Efficient frontier

4. *(a)* What are the values of—

(i) standard deviation of expected return of risk-free asset;

(ii) covariance of any two sets of returns of risk-free asset;

(iii) correlation between risky asset and risk-free asset? 1×3=3

Or

Write a short note on Capital Market Line (CML). 3

(b) Determine the expected rate of return with CAPM for the following five stocks :

Stock	*Beta*
A	0·70
B	1·00
C	1·15
D	1·40
E	−0·30

where economy's PER = 0·05 and expected return on the market portfolio $E(R_M) = 0 \cdot 09$. 5

(c) What is beta of a portfolio? Write the formula for beta of a portfolio. Interpret beta of 1·20 and 0·70. 2+1+2=5

(d) What is security market line? How do you identify that an asset is properly valued, overvalued or undervalued on the graph of Security Market Line (SML)? 2+3=5

Or

Identify the following stocks which are properly valued, overvalued and undervalued : 5

Stock	*Expected Return* $E(R_i)$	*Estimated Return*
A	7·80	8·00
B	9·00	6·20
C	9·60	15·15
D	10·60	5·16
E	3·80	6·00

(e) Suppose that during the most recent 10 years period the average annual total rate of return including dividends on an aggregate market portfolio was 14 percent ($\overline{R}_M = 0 \cdot 14$) and the average nominal rate of return on government *T*-bills was 8 per cent ($\overline{RFR} = 0 \cdot 08$). As administrator of a large pension fund that has been divided among three money managers during the past 10 years. Decide by calculating *T* values whether to renew their investment management contracts based on the following results :

Investment Manager	*Average Annual Rate of Return*	*Beta*
W	0·12	0·90
X	0·16	1·05
Y	0·18	1·20

Also plot their portfolios with security market line (SML). 7

Paper : DSE–1.3

(Financial Mathematics)

(For 2020 batch only)

1. *(a)* Let demand function of an item is represented by $12q + 15p = 190$. Write the inverse demand function. 1

(b) Among demand and supply functions, write which function changes after introduction of excise tax. 1

(c) Define equilibrium set for a market. 2

(d) Define a first-order recurrence. 2

(e) Describe intervals of compounding. 4

Or

Let supply and demand functions for an item are $q^S(p) = bp - a$ and $q^D(p) = c - dp$. If an excise tax *T* per unit is imposed ($T \neq 0$), then find the resulting market price p^T.

2. Answer any *two* from the following questions : 4×2=8

(a) Describe Cobweb model.

(b) Let supply and demand sets for an item are

$$S = \{(q, p) : 2p - 3q = 12\}$$
$$D = \{(q, p) : 2p + q = 20\}$$

and initial price $p_0 = 10$. Find an expression for the price in the year t.

(c) For the functions

$$S = \{(q, p) : q = bp - a\}$$
$$D = \{(q, p) : q = c - dp\}$$

describe stable and unstable market.

3. (a) Define revenue. 1

(b) Write about inflexion point. 2

(c) Let $I(q) = -14 + 6q - 0{\cdot}2q^2$ be the profit function of a firm which can produce 12 units per day. Find maximum profit. 5

Or

The supply and demand functions are defined by $2q - 5p = 14$ and $3q + 2p = 72$. An excise tax T per unit is imposed. Determine when revenue will be maximum.

4. (a) Write when demand is called inelastic. 1

(b) Define elasticity of demand. 2

(c) Define startup point and breakeven point. 2+2=4

(d) Explain competition versus monopoly. 5

Or

Let the demand is represented by $q = ke^{-m}$, where k, m are constants. Explain elasticity.

5. (a) Explain the three cases how prices of two items may be related to each other. 4

(b) Find and classify the critical points of

$$f(x, y) = x^3 - y^3 - 2xy + 1$$ 6

Or

Find the maximum value of the function

$$f(x, y) = 6 + 4x - 3x^2 + 4y + 2xy - 3y^2$$

6. *(a)* Define arbitrage portfolio. 2

(b) Answer any *two* from the following questions : 5×2=10

(i) Let

$$A=\begin{bmatrix}2 & 1\\ 0 & 1\end{bmatrix} \text{ and } A^n=\begin{bmatrix}a_n & b_n\\ c_n & d_n\end{bmatrix}$$

Find recurrence equations for a_n, b_n, c_n and d_n.

(ii) Describe technology matrix.

(iii) Describe a two-industry economy.

7. *(a)* Define cash flow. 1

(b) Define hedging. 1

(c) Write about investment. 2

(d) Describe comparison principle. 2

8. *(a)* Write the alternative name of interest. 1

(b) Define effective interest rate. 1

(c) Write True or False : 1

Effective interest rate and nominal rate are same.

(d) Write the relation between future value and present value. 2

(e) Find the internal rate of return of the cash flow sequence (1, −1, 0, 1). 5

Or

Show that in simple interest, account grows linearly with time.

(f) Describe municipal bonds and callable bonds. 4

Paper : DSE–1.3

(Financial Mathematics)

(For 2019 batch only)

UNIT—I

1. Answer the following as directed : 1×4=4

(a) Write the alternative name of interest.

(b) Define effective interest rate.

(c) Effective interest rate and nominal rate are same.

(Write True or False)

(d) Define discount factor.

2. Answer the following questions : 2×4=8

(a) Write about investment.

(b) Describe comparison principle.

(c) Write risk aversion principle.

(d) Define derivative asset.

3. Answer any *four* of the following questions : 6×4=24

(a) Show that in simple interest, account grows linearly with time.

(b) Show that for a cash flow stream $(x_0, x_1, x_2, \cdots, x_n)$ and an interest r per period the present value is

$$x_0 + \frac{x_1}{1+r} + \frac{x_2}{(1+r)^2} + \cdots + \frac{x_n}{(1+r)^n}$$

(c) Find the internal rate of return of the cash flow sequence (1, −1, 0, 1).

(d) Describe municipal bonds and callable bonds.

(e) Write the uses and importance of hedging.

4. Describe comparison principle. 4

UNIT—II

5. Answer the following questions : 1×4=4

(a) Define no-arbitrage assumption.

(b) Write the relation between future value and present value.

(c) Define annuity.

(d) Write when Jensen's index is zero.

6. Answer the following questions : 2×4=8

(a) Write the risk aversion principle.

(b) Define derivative asset.

(c) Write two variations to the generic coupon bond.

(d) Write the linearity property of expected value.

7. Answer any *two* of the following questions : 4×2=8

(a) Compute future value of cash flow stream (−1, 2, 1, 1·5), the periods are years and interest rate is 10%.

(b) Describe price yield curves.

(c) Describe Macaulay duration.

(d) Describe immunization.

8. Answer any *four* of the following questions : 5×4=20

(a) Describe three government securities.

(b) Find the corresponding effective rate for 3%, compounded monthly.

(c) Show that $\frac{dp}{d\lambda} = -D_m P$ with usual notations.

(d) Describe the process of computing internal rate of return.

(e) Describe Markowitz model.

(f) State and describe capital asset pricing model.

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Total No. of Printed Pages—23

5 SEM TDC DSE MTH (CBCS)
2.1/2.2/2.3/2.4 (H)

2022

(Nov/Dec)

MATHEMATICS

(Discipline Specific Elective)

(For Honours)

Paper : DSE–2.1/2.2/2.3/2.4

The figures in the margin indicate full marks for the questions

Paper : DSE–2.1

(Mathematical Modelling)

Full Marks : 60

Pass Marks : 24

Time : 3 hours

1. *(a)* What do you mean by a power series solution to a differential equation? 1

(b) What is regular point of a differential equation? 1

2. *(a)* Find the regular-singular points of the differential equation

$$(1-x^2)y''-2xy'+\lambda(\lambda+1)y=0$$

where λ is a real constant. 3

(b) Solve the following Bessel equation of order zero : 6

$$x^2y''+xy'+x^2y=0$$

Or

Consider the Legendre's equation

$$(1-x^2)y''-2xy'+\lambda(\lambda+1)y=0,$$

λ is non-negative. Show that if λ is a positive odd integer, $2n+1$, then the series solution y_2 reduces to a polynomial of degree $2n+1$ containing only odd powers of x.

3. *(a)* Find the inverse Laplace transform of $\left(\frac{1}{1+s}\right)$ and $\left(\frac{1}{s-1}\right)$. 2

(b) State and prove first shifting theorem of Laplace transform. 3

(c) Find the inverse Laplace transform of

$$\frac{30}{s^7}+\frac{8}{s-4}$$ 4

(d) Solve the initial-value problem using the Laplace transform $y''+9y=27t^3$ with $y(0)=0$ and $y'(0)=0$. 5

4. *(a)* Write the importance of Monte Carlo simulation technique. 2

(b) Explain classical Monte Carlo method with an example. 3

5. *(a)* Write two disadvantages of middle square method for generation of random number. Write the algorithm for generation of random number using middle square method. 5

(b) What is linear congruence method? How does it work? Explain with an example. 5

6. *(a)* Explain about morning rush hour queuing model with an example. 5

Or

(b) Explain about Harbor model with an example.

7. Answer any *three* of the following questions : 5×3=15

(a) A nutritionist advises an individual who is suffering from iron and vitamin B deficiency to take at least 2400 mg (milligrams) of iron, 2100 mg of vitamin B1 (thiamine), and 1500 mg of vitamin B2 (riboflavin) over a period of time. Two vitamin pills are suitable, brand–*A* and brand–*B*. Each brand–*A* pill costs ₹ 60 and contains 40 mg of iron, 10 mg of vitamin B1 and 5 mg of vitamin B2. Each brand–*B* pill costs ₹ 80 and contains 10 mg of iron and 15 mg each of vitamins B1 and B2. What combination of pills should the individual purchase in order to meet the minimum iron and vitamin requirements at the lowest cost? (Use graphical method) :

	Brand–A	*Brand–B*	*Minimum requirement*
Iron	40 mg	10 mg	2400 mg
Vitamin B1	10 mg	15 mg	2100 mg
Vitamin B2	5 mg	15 mg	1500 mg
Cost/Pill	₹ 60	₹ 80	

(b) A manufacturer produces three types of plastic fixtures. The time required for molding, trimming and packaging is given in the following table (Times are given in hours per dozen fixtures). How many dozens of each type of fixture should be produced to obtain a maximum profit?

	Type–A	*Type–B*	*Type–C*	*Total time available*
Molding	1	2	3/2	1200
Trimming	2/3	2/3	1	4600
Packaging	1/2	1/3	1/2	2400
Profit	₹ 1,100	₹ 1,600	₹ 1,500	—

(c) A company has two grades of inspectors, *I* and *II* to undertake quality control inspection. At least 1500 pieces must be inspected in an 8-hour day. Grade *I* inspector can check 20 pieces in an hour with an accuracy of 96%. Grade *II* inspector checks 14 pieces an hour with an accuracy of 92%. Wages of grade *I* inspector are ₹ 5 per hour while those of grade *II* inspector are ₹ 4 per hour. Any error made by an inspector costs ₹ 3 to the company.

If there are, in all, 10 grade *I* inspectors and 15 grade *II* inspectors in the company, find the optimal assignment of inspectors that minimize the daily inspection cost.

(d) A manufacturer of cylindrical containers receives tin sheets in widths of 30 cm and 60 cm respectively. For these containers the sheets are to be cut to three different widths of 15 cm, 21 cm and 27 cm respectively. The number of containers to be manufactured from these three widths are 400, 200 and 300 respectively. The bottom plates and top covers of the containers are purchased directly from the market. There is no limit on the lengths of standard tin sheets. Formulate the LPP for the production schedule that minimizes the trim losses.

Paper : DSE–2.2

(Mechanics)

Full Marks : 80

Pass Marks : 32

Time : 3 hours

UNIT—1

1. *(a)* A force $\vec{F}_1 = (10\hat{i} + 6\hat{j} + 3\hat{k})$ acts at position (3, 0, 2). At point (0, 2, −3), an equal but opposite force $-\vec{F}_1$ acts. Calculate the couple moment. 2

(b) Show that any number of coplanar couples, acting on a body is equivalent to a single couple whose moment is equal to the algebraic sum of the moments of the couples. 6

Or

Show that two couples in the same plane whose moments are equal and of the same sign are equivalent to one another.

2. *(a)* Write down the condition of equilibrium of any number of concurrent forces. 2

(b) Three forces $\vec{P}$, $\vec{Q}$, $\vec{R}$ acting along $\overrightarrow{OA}$, $\overrightarrow{OB}$, $\overrightarrow{OC}$ are in equilibrium. If O be the circum-centre of the triangle ABC, then show that

$$\frac{P}{\frac{1}{b^2}+\frac{1}{c^2}-\frac{a^2}{b^2c^2}} = \frac{Q}{\frac{1}{c^2}+\frac{1}{a^2}-\frac{b^2}{c^2a^2}} = \frac{R}{\frac{1}{a^2}+\frac{1}{b^2}-\frac{c^2}{a^2b^2}}$$

where a, b, c are the lengths of the sides $\overrightarrow{BC}$, $\overrightarrow{CA}$, $\overrightarrow{AB}$. 7

Or

An electric light fixture weighing 15 N hangs from a point C by two strings AC and BC. The string AC is inclined at 60° to the horizontal and BC at 45° to the horizontal. Draw the free body diagram and determine the forces in the strings AC and BC.

(c) What do you mean by distributed force system? Give an example of it. 2+1=3

UNIT—2

3. (a) What do you mean by coefficient of friction? Write down the dimension of coefficient of friction. 2+1=3

(b) The horizontal position of the 500 kg rectangular block of concrete is adjusted by the 5° wedge under the action of the force P. If the coefficient of friction for both wedge surfaces is 0·30 and the coefficient of friction between block and horizontal surface is 0·60, then determine the least force P required to move the block. 7

Or

A smooth sphere of weight W, rests between a vertical wall and a prism, one of whose faces rests on a horizontal plane, if the coefficient of friction between the horizontal and prism is μ. Show that the least weight of the prism consistent with the equilibrium is $W\left(\frac{\tan\alpha}{\mu}-1\right)$, where α is the inclination to the horizon of the face in contact with the sphere.

4. (a) A plane surface is bounded by x-axis, the curve $y^2 = 25x$ and the line $x = 10$. Calculate the moments of the area about x and y axes. What are the centroidal coordinates? 3+2=5

(b) Define second moment of area and product of area. 2+2=4

(c) Find I_{xx}, I_{yy} and I_{xy} for the area bounded by the curves $y = x^2$ and $y^2 = 3x$. 2+2+2=6

Or

Define polar moment of area. Show that the polar moment of area of a circular area of radius r is $\frac{\pi r^4}{2}$ at the centre. 2+4=6

UNIT—3

5. (a) Show that a conservative force field is a function of position and gradient of a scalar field. 4

(b) Give two examples of conservative force field. 2

(c) Show that the sum of the potential energy and the kinetic energy for a particle remains constant for all times during the motion of the particle.

A particle is dropped with zero initial velocity down a frictionless chute. What is the magnitude of the velocity if the vertical drop during the motion is h ft? 4+3=7

Or

Given the following conservative force field :

$$\vec{F} = (10z + y)\hat{i} + (15yz + x)\hat{j} + \left(10x + \frac{15y^2}{2}\right)\hat{k}$$

Find the force potential.

Also, calculate the work done by $\vec{F}$ on a particle going from $\vec{r}_1 = 10\hat{i} + 2\hat{j} + 3\hat{k}$ to $\vec{r}_2 = -2\hat{i} + 4\hat{j} - 3\hat{k}$. 4+3=7

6. (a) A reference xyz is moving such that the origin O has at time t, a velocity relative to reference XYZ given as

$$\vec{V}_O = 6\hat{i} + 12\hat{j} + 13\hat{k}$$

The xyz reference has an angular velocity $\vec{\omega}$ relative to XYZ at time t, given as

$$\vec{\omega} = 10\hat{i} + 12\hat{j} + 2\hat{k}$$

What is the time rate of change of a directed line segment ρ going from $(3, 2, -5)$ to $(-2, 4, 6)$ in xyz relative to XYZ? 4

(b) What do you mean by translation and rotation of rigid body? 2+2=4

(c) An airplane moving at 200 ft/sec is undergoing a roll of 2 rad/min. When the plane is horizontal, an antenna is moving out at a speed of 8 ft/sec relative to the plane and is at a position of 10 ft from the centre line of the plane. If we assume that the axis of roll corresponds to the centre line, what is the velocity of the antenna end relative to the ground? 5

Or

State and prove Chasles' theorem.

7. (a) Establish the relation between acceleration vectors of a particle for two systems of references moving arbitrarily relative to each other. 5

Or

Find the kinetic energy of rigid body rotating about a fixed point.

(b) Derive the moment of momentum equation for a single particle. 4

Paper : DSE–2.3

(Number Theory)

Full Marks : 80

Pass Marks : 32

Time : 3 hours

1. (a) Define a linear Diophantine equation. 1

(b) If p be a prime number and a be any integer, then prove that either $p|a$ or $(a, p) = 1$. 2

(c) Find the general solution of $10x - 8y = 42$. 3

(d) If a, b, c be integers such that $ac \equiv bc \pmod{m}$ and $d = (c, m)$, then show that

$$a \equiv b\left(\bmod \frac{m}{d}\right)$$ 4

Or

State and prove fundamental theorem of arithmetic.

2. *(a)* Define CRS (mod m). 1

(b) What is the remainder when 5^{48} is divided by 12? 2

(c) Solve $6x \equiv 15 \pmod{21}$. 3

(d) Prove that an integer p is a prime if and only if

$$(p-1)! \equiv -1 \pmod{p}$$ 4

Or

State and prove Chinese remainder theorem.

3. *(a)* Define Möbius function. 1

(b) Find $\tau(n)$ and $\sigma(n)$, when $n = 12$. 3

(c) Prove that

$$\frac{\phi(n)}{n} = \sum_{d|n} \frac{\mu(d)}{d}$$ 3

Or

Find $\sum_{d|n} \phi(d)$ if $n = 12$.

(d) If n be an integer >1, then show that $\tau(n)$ is odd $\Leftrightarrow$ n is a perfect square. 3

(e) If f is a multiplicative arithmetic function, then prove that

$$g_1(n) = \sum_{d|n} f(d) \text{ and } g_2(n) = \sum_{d|n} \mu(d)\, f(d)$$

are both multiplicative arithmetic functions. 5

Or

If $n = p_1^{k_1} p_2^{k_2} \ldots p_r^{k_r}$ is the prime factorization of $n > 1$, then prove that

$$\sigma(n) = \frac{p_1^{k_1+1} - 1}{p_1 - 1} \cdot \frac{p_2^{k_2+1} - 1}{p_2 - 1} \cdot \ldots \frac{p_r^{k_r+1} - 1}{p_r - 1}$$

and $\tau(n) = (k_1 + 1)(k_2 + 1) \ldots (k_r + 1)$

4. *(a)* If x and y be any real numbers, then show that—

(i) $[x + m] = [x] + m$, m be any integer;

(ii) $[x] + [y] \le [x + y] \le [x] + [y] + 1$. 2+2=4

(b) If n be any integer >2, then prove that $\phi(n)$ is even. 3

(c) Evaluate $\phi(450)$. 3

(d) Let a and $m > 0$ be integers such that $(a, m) = 1$, then prove that

$$a^{\phi(m)} \equiv 1 \pmod{m}$$ 5

Or

For each positive integer $n \geq 1$, then show that

$$n = \sum_{d \mid n} \phi(d)$$

the sum being extended over all positive divisors of n.

5. (a) If a be an integer having exponent h modulo m, i.e., $a^h \equiv 1 \pmod{m}$, then prove that

$$(a, m) = 1$$

that is a and m are coprime. 2

(b) If a has exponent h modulo m, then prove that a^k has exponent $\frac{h}{d}$, where $d = (h, k)$. 4

(c) Find the primitive roots (mod 7). 4

(d) Define Legendre symbol and if p be an odd prime and a, b be any integers coprime to p, then prove that

$$\left(\frac{ab}{p}\right) = \left(\frac{a}{p}\right)\left(\frac{b}{p}\right)$$ 5

Or

Let a be any odd integer, then show that

$$a^{2^{n-2}} \equiv 1 \pmod{2^n}, \quad \forall\, n \geq 3$$

6. (a) Evaluate the Legendre symbol $\left(\frac{-168}{11}\right)$. 2

(b) Show that the number of primes is not finite. 3

(c) Encrypt the message 'RETURN HOME' using Caesar cipher. 2

(d) If x, y, z is a primitive Pythagorean triple, then show that one of the integers x and y is even, while the other is odd. 3

(e) If p is an odd prime and $(a, p) = 1$, then show that $x^2 \equiv a \pmod{p^k}$, $k \geq 1$ has a solution if and only if $\left(\frac{a}{p}\right) = 1$. 5

Or

Show that an integer a is a quadratic residue $\pmod{p}$ if and only if $a^{\frac{p-1}{2}} \equiv 1 \pmod{p}$.

Paper : DSE–2.4

(Biomathematics)

Full Marks : 80

Pass Marks : 32

Time : 3 hours

UNIT—I

1. Answer any *two* of the following questions : 7½×2=15

(a) Explain Allee effect with suitable illustration.

(b) Discuss the host-parasite problem by finding dy/dx and sketching the trajectories in the xy-plane for the case when—

(i) the birthrate equals the death rate in the host population;

(ii) none of the parasites' eggs hatch.

(c) The logistic differential equation is

$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right)$$

Show that $N(t) = \frac{K}{1 + Ce^{-rt}}$, where $C = \frac{K - N_0}{N_0}$, is a solution with initial condition $N(0) = N_0$. Here symbols have their usual meanings.

UNIT—II

2. Answer any *two* of the following questions : 7½×2=15

(a) Show that in an SIR model with carriers who show no symptoms of the disease, the disease always remains endemic.

(b) Suppose that prey have a refuge from predators into which they can retreat. Assume that refuge can hold a fixed number of prey. How would you model this situation, and what predictions can you make?

(c) Explain the SIRS model with suitable illustrations.

(Continued)

UNIT—III

3. Answer any *two* of the following questions : 7½×2=15

(a) The interaction between two populations with densities N_1 and N_2 is modelled by

$$\frac{dN_1}{dt} = r N_1\left(1 - \frac{N_1}{K}\right) - aN_1 N_2(1 - \exp[-bN_1])$$

$$\frac{dN_2}{dt} = -dN_2 + N_2 e(1 - \exp[-b N_1])$$

where a, b, d, e, r, K are positive constants. What type of interaction exists between N_1 and N_2? What do the various terms imply ecologically?

(b) Write down all Routh-Hurwitz matrices $\mathbf{H}_1$, $\mathbf{H}_2$ and $\mathbf{H}_3$ for the case of three species. Show that May's conditions are equivalent to the original Routh-Hurwitz criteria by evaluating the determinants of these matrices.

(c) Suppose x is a predator and y and z both its prey. z grows logistically in the absence of its predator. x dies out in the absence of prey, and y grows at an exponential rate in the absence of predator. Use Routh-Hurwitz techniques to examine whether these species can coexist in a stable equilibrium.

(Turn Over)

UNIT—IV

4. Answer any *two* of the following questions : 7½×2=15

(a) Discuss the stability of the following system :

$$x_{t+3} + 9x_{t+2} - 5x_{t+1} - 2x_t = 0$$

(b) Suppose a gene has 3 alleles in equilibrium in a randomly mating population. To find allele frequencies for the population, what is the minimum number of phenotype frequencies you must know? Answer the same question for n alleles.

(c) Write a short note on blood flow in circulatory system.

UNIT—V

5. Answer any *two* of the following questions : 10×2=20

(a) Discuss the possibility of the existence of a stable age-structure, i.e., age-structure which does not change with time.

(*Continued*

(b) Describe Nicholson-Bailey model for host parasite systems.

(c) Consider positive assortative mating, i.e., individuals mate only with those of like genotype. In contrast to random mating, set up a model for positive assortative mating. What conclusion do you reach?

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Total No. of Printed Pages—7

5 SEM TDC DSE CHM (CBCS) 2 (H)

2022

(Nov/Dec)

CHEMISTRY

(Discipline Specific Elective)

(For Honours)

Paper : DSE–2

(Green Chemistry)

Full Marks : 53

Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct answer : 1×6=6

(a) The Minamata disease has been attributed to

(i) lead poisoning

(ii) arsenic poisoning

(iii) cadmium poisoning

(iv) mercury poisoning

(b) The 'methaemoglobinaemia' (blue baby syndrome) has been attributed to

(i) nitrous oxide poisoning

(ii) nitrite poisoning

(iii) nitrate poisoning

(iv) carbon monoxide poisoning

(c) The concept of 'atom economy' was developed by

(i) Paul T. Anastas

(ii) John C. Warner

(iii) B. M. Trost

(iv) John R. Asthana

(d) The addition of HBr to propene is an example of

(i) chemoselective reaction

(ii) regioselective reaction

(iii) enantioselective reaction

(iv) diastereoselective reaction

(Continued)

(e) Solar energy is considered to be a

(i) renewable source of energy

(ii) non-renewable source of energy

(iii) Both renewable and non-renewable sources of energy

(iv) None of the above

(f) Which of the following is considered as green solvent?

(i) Supercritical CO_2

(ii) Ionic liquids

(iii) Water

(iv) All of the above

UNIT—I

2. Answer the following questions (any *seven*) : 2×7=14

(a) What is Bhopal Gas Tragedy? Write the greener approach to the Bhopal Gas Tragedy. 1+1=2

(b) Write one 100% atom economical reaction.

(c) What is regioselective reaction? Give one example of it. 1+1=2

(d) What is diastereoselective reaction? Give one example of it. 1+1=2

(e) Mention four advantages of using biocatalysis in relevance to green chemistry. ½×4=2

(f) Write the green approach of synthesis of methyl methacrylate with 100% atom economy.

(g) Write a method of preparation of urethane eliminating the use of hazardous chemical, phosgene.

(h) Give one example of Hofmann elimination using microwave irradiation.

UNIT—II

3. Answer the following questions (any *five*) : 3×5=15

(a) Explain any two principles of green chemistry. 1½+1½=3

(b) Synthesis of 3°-alcohol from Grignard reagent gives 100% yield but the reaction is not considered to be a green synthesis. Explain.

(c) What are solid-state reactions? Write the synthesis of imidazole using KSF clay under solvent-free conditions in microwave. 1+2=3

(d) What are sonication reactions? Explain with a suitable reaction. 1+2=3

(e) What is biocatalyst? Write the biocatalytic conversion of penicillin into 6-APA. 1+2=3

(f) "Catalysts can control the stereo-chemistry of a reaction." Explain with conversion of 2-butanone into (*R*)-alcohol with biocatalyst as a typical enantioselectivity of reduction.

UNIT—III

4. Answer the following questions (any *three*) : 3×3=9

(a) Explain the green approach of synthesis of catechol. Why is it considered as green process? 2+1=3

(b) Explain the green approach of synthesis of citral. Why is it considered as green process? 2+1=3

(c) Explain the green approach of synthesis of paracetamol. Why is it considered as green process? 2+1=3

(d) Explain the green approach of conversion ethanol into ethanoic acid. Why is it considered as green process? 2+1=3

UNIT—IV

5. Answer the following questions (any *three*) : 3×3=9

(a) Mention some green chemistry works towards sustainability.

(b) Mention some guidelines to be followed to control the pollution due to industrial effluents.

(c) What will be the future trends in green chemistry in the field of catalysts?

(d) What will be the future trends in green chemistry in the field of multi-functional reagents?

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Total No. of Printed Pages—8

5 SEM TDC DSE PHY (CBCS) 1 (H)

2022

(Nov/Dec)

PHYSICS

(Discipline Specific Elective)

(For Honours)

Paper : DSE-1

(Classical Dynamics)

Full Marks : 80
Pass Marks : 32

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct answer : 1×8=8

(a) An alpha particle with mass m, charge $2e$ enters into a magnetic field B with velocity v perpendicular to the direction of the magnetic field. The radius of the curved path is

(i) $\frac{mv}{eB}$ *(ii)* $\frac{mv}{2eB}$

(iii) $\frac{2mv}{eB}$ *(iv)* $\frac{mv}{4eB}$

(b) In Lagrange's equation, if there are N numbers of particles and so the generalized coordinates are

(i) $n = N - K$

(ii) $n = 3N - K$

(iii) $n = 3N$

(iv) $n = 3n - K$

(c) Hamilton proved that the actual path followed by the physical system between the two states in the given time is the one for which this integral is

(i) maximized

(ii) negative

(iii) minimized

(iv) undefined

(d) For small amplitude oscillation potential energy curve with respect to distance travelled from equilibrium position is

(i) parabolic

(ii) hyperbolic

(iii) elliptical

(iv) circular

(e) The time dilation factor of a muon travelling with a velocity of 80% that of velocity of light is

(i) 0·60

(ii) 1·66

(iii) 0·20

(iv) 5·0

(f) The relativistic formula for kinetic energy is

(i) $T = (m - m_0)c^2$

(ii) $T = mc^2$

(iii) $T = \frac{1}{2}mc^2$

(iv) $T = m_0c^2$

(g) If an object approaches the speed of light, then its mass

(i) becomes zero

(ii) becomes double

(iii) remains same

(iv) becomes infinite

(h) Which of the following is the basic principle of fluid mechanics?

(i) Momentum principle

(ii) Energy equation

(iii) Continuity equation

(iv) All of the above

2. *(a)* Show that the radius of curvature of a charged particle moving at right angles to a magnetic field is proportional to its momentum. 2

Or

Find the gyro-radius and cyclotron frequency of *(i)* a proton and *(ii)* an electron travelling with velocity 10 cms^{-1} in a field of 10000 gauss.

(b) Define generalized coordinates and state the expressions for *(i)* generalized velocity and *(ii)* generalized force. 1+1+1=3

(c) Find the Lagrange's equations of motion for an electrical circuit comprising an inductance L and capacitance C. The condenser is charged to q coulomb and the current flowing in the circuit is I ampere. 3

3. *(a)* Establish the equation of motion of one-dimensional harmonic oscillator using Hamilton's principle. 4

(b) A mass m is at one end of a spring of natural length l and spring constant K. Find Lagrangian of the system and apply Lagrange's equation of motion. (The mass moves up and down in the vertical direction.) 4

Or

Find the expression for Hamiltonian of a particle moving under a central force field and also write Hamilton's equation of motion for this particle.

(c) Derive Hamilton's canonical equations of motion in generalized coordinates and explain the significance of Hamiltonian. 3+2=5

Or

Discuss the situations under which the energy of a system of interest is conserved and show that energy is essentially the generalized momentum conjugate to time. 5

4. *(a)* What do you understand by stable and unstable equilibria? 3

(b) A solid homogeneous cylinder of radius r rolls without slipping on the inside of stationary large cylinder of radius R.

(i) Find the equation of motion.

(ii) What is the period of small oscillations about the stable equilibrium position? 3+3=6

Or

What are normal coordinates? Discuss the normal frequencies of a vibrating string fixed at both ends, treating it as the limiting case of a system of coupled particles. 6

5. *(a)* Show how Lorentz transformation equations are superior to Galilean transformations. 2

(b) With the help of Lorentz transformation, deduce an expression for the apparent time interval measured in a frame of reference that has a velocity v relative to the watch used for measurement of time. 3

Or

A meson has a speed $0{\cdot}8c$ relative to the ground. Find how far the meson relative to the ground, if its speed remains constant and the time of its flight, relative to the system, in which it is at rest, is 2×10^{-8} sec.

(c) Obtain Einstein's formula for addition of velocities. 3

(d) How does mass change with velocity? Show that c is the ultimate speed of the particles. 2+1=3

6. *(a)* Derive an expression for the kinetic energy of a relativistic particle. Hence deduce the Einstein's mass-energy relation. 3+1=4

(b) Deduce the expressions for 4-velocity and 4-acceleration. 2+2=4

(c) A rocket ship is 100 m long on the ground. When it is in flight, its length is 99 m to an observer on the ground. What is its speed? 4

Or

The total energy of a particle is exactly twice its rest energy. Calculate its speed.

7. *(a)* Obtain an expression for the velocity of a particle in terms of relativistic momentum and energy. 5

(b) Assuming the law of conservation of momentum to be correct in every inertial frame, show that by the use of transformation of energy and momentum, the relativistic energy is conserved in a two-particle system. 5

Or

A spectral line of wavelength 4×10^{-7} m in the spectrum of light from a star is

found to be displaced from its normal position towards the red end of the spectrum by an amount equivalent to 10^{-10} m. What velocity of the star would account for this?

8. *(a)* Distinguish between streamline and turbulent motion of a liquid. 2

(b) Define coefficient of viscosity. Establish Poiseuille's equation. What are the limitations of the equation? 3

Or

A vessel of cross-section 20 sq. cm has a horizontal capillary tube of length 10 cm and internal radius 0·5 mm at its bottom. It is initially filled with water to a height of 20 cm above the capillary tube. Find the time taken by the vessel to empty one-half of its contents, given that viscosity of water is 0·01 poise.

(c) Derive Navier-Stokes equation. What is the incompressibility condition in Navier-Stokes equation? 3+1=4

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5 SEM TDC DSE BOT (CBCS) 1 (H/NH)

2022

(Nov/Dec)

BOTANY

(Discipline Specific Elective)

(For Honours & Non-Honours)

Paper : DSE–1

(Analytical Techniques in Plant Science)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. *(a)* তলত দিয়াবোৰৰ শুদ্ধ উত্তৰটো বাচি উলিওৱা : 1×3=3

Choose the correct answer of the following :

(i) যদি এটা সাধাৰণ অনুবীক্ষণ যন্ত্ৰৰ অভিনেত্ৰৰ বিৱৰ্ধন ক্ষমতা ×10 আৰু লক্ষ্যৰ ×40 হয়, তেতিয়া সম্পূৰ্ণ বিৱৰ্ধন হ'ব ×40 / ×10 / ×400 / ×4.

If the eyepiece magnification on light microscope is ×10 and objective is ×40, then the overall magnification is ×40 / ×10 / ×400 / ×4.

(ii) R_f মান ব্যৱহৃত হয় স্পেক্ট্রফট'মিটাৰ / ক্রমেটগ্রাফী / ইলেক্ট্রফ'ৰেছিছ / এইবোৰৰ এটাতো নহয়।

R_f value is used in spectrophotometry / chromatography / electrophoresis / None of these.

(iii) যদি n এটা অযুগ্ম সংখ্যা, তেন্তে মেডিয়ান হৈছে মাজৰ মান / মানসমূহৰ যোগফল / দুটা মাজৰ মানৰ মধ্যম মান / আটাইতকৈ বেছি পুনৰাবৃত্ত মান।

When n is an odd number, then median is defined as middle value / sum of the values / median of two middle values / most repeated value.

(b) খালী ঠাই পূৰ কৰা : 1×2=2

Fill in the blanks :

(i) _____ ক্রমেটগ্রাফীত, স্থিৰ মাধ্যমটো এটা টেক নলত আৰু চলমান মাধ্যমটো উচ্চ চাপত ইয়াৰ মাজেৰে পাৰ কৰোৱা হয়।

In _____ chromatography, the stationary phase is held in a narrow tube and the mobile phase is forced through it under high pressure.

(ii) ইলেক্ট্রফ'ৰেছিছ পদ্ধতিটো _____এ বিকাশ কৰিছিল।

The technique of electrophoresis was developed by _____.

(Continued)

2. চমু টোকা লিখা (যি কোনো তিনিটা) : 4×3=12

Write short notes on (any *three*) :

(a) কোষৰ ভগ্নাংশীকৰণ

Cell fractionation

(b) ঘনত্ব অনুসৰি প্ৰৱাহিত চেন্ট্রিফিউগেছন

Density-gradient centrifugation

(c) পেজ

Page

(d) ক্রম'জ'মৰ চিত্রাঙ্কন

Chromosome painting

3. ইলেক্ট্রন অনুবীক্ষণ যন্ত্ৰৰ বাবে নমুনা প্রস্তুত কৰোঁতে ব্যৱহৃত বিভিন্ন প্রযুক্তিসমূহ ব্যাখ্যা কৰা। কোষাৱৰণৰ গঠন অধ্যয়নত ফ্রীজ ফ্রেক্চাৰ প্রযুক্তি কেনেকৈ সহায় কৰে, উল্লেখ কৰা। ফ্রীজ ইচিঙৰ পৰা ফ্রীজ ফ্রেক্চাৰ কিয় পৃথক? 4+5+3=12

Explain the different techniques used in sample preparation for electron microscopy. Describe how freeze fracture technique helps in understanding the membrane structure. How is freeze fracture different from freeze-etching?

অথবা / Or

জেল ইলেক্ট্রফ'ৰেছিছ কি? ইয়াৰ সহায়ত নিউক্লিক এচিড পৃথক কৰাৰ পদ্ধতিটো ব্যাখ্যা কৰা। 3+9=12

What is gel electrophoresis? Describe the method of separation of nucleic acid by gel electrophoresis.

(Turn Over)

4. এটা স্পেক্ট্রফট'মিটাৰৰ কাৰ্যতত্ত্ব আৰু যন্ত্ৰশৈলীৰ বৰ্ণনা কৰা। জীৱবিজ্ঞানৰ গৱেষণাত ইয়াৰ গুৰুত্ব কি? (3+4)+5=12

Describe the working principle and instrumentation of a spectrophotometer. Also discuss its role in biological research.

অথবা / Or

স্থূলানু বিনিময় ক্ৰমেটগ্ৰাফী বুলিলে কি বুজা? এই প্ৰক্ৰিয়াৰ মূল তত্ত্ব, যন্ত্ৰশৈলী আৰু ব্যৱহাৰবোৰ বৰ্ণনা কৰা। 3+(3+3+3)=12

What is ion exchange chromatography? Describe its principle, instrumentation and uses.

5. মান বিচ্যুতি বুলিলে কি বুজা? তলৰ তথ্যসমূহৰ পৰা গড়, বহুলক আৰু মধ্যমা উলিওৱা : 3+(3+3+3)=12

What is standard error? Calculate the mean, mode and median from the following data :

CI	0–10	10–20	20–30	30–40	40–50
Frequency	5	8	15	16	6

অথবা / Or

জীৱবিজ্ঞানত পৰিসংখ্যা বিজ্ঞানৰ প্ৰয়োগৰ প্ৰয়োজনীয়তা উদাহৰণৰ সৈতে আলোচনা কৰা। 8+4=12

Discuss the necessity of the application of statistical sciences in biological sciences with example.

★★★

Total No. of Printed Pages—11

5 SEM TDC DSE CHM
(CBCS) 1 (H/NH)

2022

(Nov/Dec)

CHEMISTRY

(Discipline Specific Elective)

(For Honours/Non-Honours)

Paper : DSE–1

(Analytical Methods in Chemistry)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. শুদ্ধ উত্তৰটো বাছি উলিওৱা : 1×7=7

Choose the correct option :

(a) 12·6, 12·7, 12·9, 12·7, 12·6, 12·8, 13·0, 12·5, 12·6 এই সাংখ্যিক মানবোৰৰ বহুলক হ'ব

The mode of the set of data 12·6, 12·7, 12·9, 12·7, 12·6, 12·8, 13·0, 12·5, 12·6 is

(i) 12·7 *(ii)* 12·6

(iii) 12·71 *(iv)* 12·75

(b) তলৰ কোনটো অতিবেঙুণীয়া-দৃশ্যমান বশ্মিৰ উৎস নহয় ?

All of the following are useful as a source for UV-visible radiation, *except*

(i) গ্ল'বাৰ উৎস

globar source

(ii) জেনন ডিছচার্জ চাকি

xenon discharge lamp

(iii) ডিউটেৰিয়াম ডিছচার্জ চাকি

deuterium discharge lamp

(iv) টাংষ্টেন ফিলামেণ্ট চাকি

tungsten filament lamp

(c) IR spectroscopy ত 'hot band' তলৰ কোনটো পৰিৱৰ্তনৰ লগত জড়িত ?

A hot band in IR spectroscopy is corresponding to the transition

(i) $\upsilon = 0$ ৰ পৰা $\upsilon = 1$

from $\upsilon = 0$ to $\upsilon = 1$

(ii) $\upsilon = 0$ ৰ পৰা $\upsilon = 2$

from $\upsilon = 0$ to $\upsilon = 2$

(iii) $\upsilon = 1$ ৰ পৰা $\upsilon = 0$

from $\upsilon = 1$ to $\upsilon = 0$

(iv) $\upsilon = 1$ ৰ পৰা $\upsilon = 2$

from $\upsilon = 1$ to $\upsilon = 2$

(Continued)

(d) তাপ-ভৰমাপক অনুসন্ধানত ভৰ বনাম উষ্ণতা চিত্ৰৰ নাম হ'ল

The mass vs. temperature plot in thermogravimetric analysis is called

(i) থাৰ্ম'গ্ৰাফ

thermograph

(ii) ক্ৰ'মেট'গ্ৰাফ

chromatograph

(iii) থাৰ্ম'গ্ৰাম

thermogram

(iv) ক্ৰ'মেট'গ্ৰাম

chromatogram

(e) প'টেনচিওমেট্ৰিক টাইট্ৰেচন হ'ল

Potentiometric titration is

(i) প্ৰত্যক্ষ প'টেনচিওমেট্ৰি

direct potentiometry

(ii) পৰোক্ষ প'টেনচিওমেট্ৰি

indirect potentiometry

(iii) ইলেক্ট্ৰ'গ্ৰেভিমেট্ৰি

electrogravimetry

(iv) ভ'ল্টামেট্ৰি

voltametry

(Turn Over)

(f) কাগজ বর্ণলেখন পদ্ধতিত গতিশীল আৰু স্থিৰ পর্যায় দুটা হ'ল ক্রমে

In paper chromatography, the moving and stationary phases are

(i) পানী আৰু চেলুল'জ

water and cellulose respectively

(ii) দ্রাৱক আৰু চেলুল'জ

solvent and cellulose respectively

(iii) দ্রাৱক আৰু পানী

solvent and water

(iv) ওপৰৰ এটাও নহয়

None of the above

(g) আধান-বিনিময় বর্ণলেখন পদ্ধতি তলৰ কোনটো কাৰকৰ ওপৰত নির্ভৰ কৰে ?

Ion-exchange chromatography is based on the

(i) ৰেজিনৰ ওপৰত কণাসমূহৰ অধিশোষণ

adsorption of molecules on resin

(ii) আয়নীয় কণিকাৰ বৈদ্যুতিক গতি

electrical mobility of ionic species

(iii) ইলেক্ট্ৰ'ষ্টেটিক আকর্ষণ

electrostatic attraction

(iv) ৰেজিন আৰু দ্রাৱকৰ মাজত বিভাজন

partition between resin and solvent

2. তলৰ প্রশ্নবোৰৰ উত্তৰ দিয়া : 2×6=12

Answer the following questions :

(a) প'টেনচিওমেট্রিক টাইট্রেচনৰ অন্তিম বিন্দু কেনেকৈ নির্ণয় কৰা হয় ? উপযুক্ত লেখচিত্রৰ সহায়ত ব্যাখ্যা কৰা।

How can the equivalence point in a potentiometric titration be detected? Explain with suitable graphs.

(b) ক্রমাগত আৰু বিপৰীত-প্রৱাহ নিষ্কাশনৰ মাজত পার্থক্য লিখা।

Differentiate between continuous and counter-current extractions.

(c) চিলেত গঠনৰ সহায়ত জলীয় দ্রৱ/পর্যায়ৰ পৰা ধাতুৰ আধান নিষ্কাশন পদ্ধতিটো আলোচনা কৰা।

Discuss the extraction of metal ions from aqueous phase by chelation.

(d) IR স্পেক্ট্ৰ'স্কপিত কঠিন পদার্থৰ নমুনা প্রস্তুতকৰণ কৰোতে 'চাপকৃত বড়ি/গুলি' পদ্ধতিটো আলোচনা কৰা।

Discuss the 'pressed pellet' technique used in sampling of solid sample in IR spectroscopy.

(e) UV-vis স্পেক্ট্ৰ'স্কপিত এবজ'ৰবেন্স আৰু ট্রান্সমিটেন্স কি ? ইহঁত কেনেদৰে সম্পর্কিত ?

What are absorbence and transmittance in UV-vis spectroscopy? How are they related?

(f) ফ্রাংক-কনড'ন নীতি কি ?

What is Franck-Condon principle?

3. তলৰ ফলাফলসমূহৰ সৰ্বোচ্চ মানটো প্ৰত্যাখ্যানযোগ্য নেকি Q-পৰীক্ষাৰ সহায়ত ঠিৰাং কৰা : 3

2·18, 2·19, 2·30, 2·15 আৰু 2·20;

দিয়া আছে, 90% আত্মবিশ্বাস স্তৰত $n = 5$ ৰ কাৰণে $Q_{tab} = 0 \cdot 64$.

Apply Q-test to check the rejection of the highest value in the following results :

2·18, 2·19, 2·30, 2·15 and 2·20

Given, for $n = 5$, $Q_{tab} = 0 \cdot 64$ at 90% confidence level.

নাইবা / Or

বিশ্লেষিত নমুনা এটাৰ আকাংক্ষিত উপাদানটোৰ প্ৰকৃত মান 2·62 গ্ৰাম। তিনিটা মাপৰ ফলাফলসমূহ হ'ল 2·50 গ্ৰাম, 2·54 গ্ৰাম আৰু 2·52 গ্ৰাম। মাপবোৰৰ গড় ত্ৰুটি, আপেক্ষিক ত্ৰুটিৰ শতাংশ আৰু গড় মানৰ আপেক্ষিক যথাৰ্থতা/সঠিকতা নিৰ্ণয় কৰা।

A sample was analyzed for desired constituent having 2·62 g as the true value. The results of three measurements were 2·50 g, 2·54 g and 2·52 g. Find the error of the mean (mean error), the percent relative error and the relative accuracy of the mean of the measurements.

(Continued)

4. *(a)* তলৰ যি কোনো এটা প্ৰশ্নৰ উত্তৰ লিখা : 3

Answer any *one* question from the following :

(i) শিখা পাৰমাণৱিক শোষণ/নিৰ্গমন স্পেক্ট্ৰ'স্কপিত নমুনা উপস্থাপন আৰু পৰমাণুকৰণ পদ্ধতি আলোচনা কৰা।

Discuss the sample introduction and atomization technique used in flame atomic absorption/emission spectroscopy.

(ii) এটা অনৈক্যতানযুক্ত দোলকৰ অনুকম্পনীয় স্থানান্তৰৰ বাবে নিৰ্বাচন বিধি লিখা। মুখ্য শোষণ আৰু অতিস্বৰ/অ'ভাৰট'ন কি? অতিস্বৰৰ তীব্ৰতা ক্ষীণ কিয়?

Write down the selection rules for vibrational transition of an anharmonic oscillator. What are the fundamental absorption and overtones? Intensities of overtone absorptions are weak. Why?

(b) তলৰ যি কোনো তিনিটা প্ৰশ্নৰ উত্তৰ লিখা : 4×3=12

Answer any *three* questions from the following :

(i) এটা UV-vis স্পেক্ট্ৰ'ফ'টোমিটাৰৰ প্ৰধান উপাংশবোৰ কি কি? উপাংশবোৰৰ গঠন আৰু কাৰ্যসমূহ চমুকৈ আলোচনা কৰা।

(Turn Over)

What are the main components of a UV-vis spectrophotometer? Briefly discuss their construction and works.

(ii) জৈৱ যৌগ এটাৰ জ্যামিতীয় আইচ'মাৰবোৰ পার্থক্য উলিয়াওঁতে UV-vis স্পেক্ট্ৰ'স্কপি কিদৰে ব্যৱহাৰ কৰা হয়? উপযুক্ত উদাহৰণসহ ব্যাখ্যা কৰা।

How can the UV-vis spectroscopy be used to distinguish the geometrical isomers of an organic compound? Explain with suitable examples.

(iii) IR-স্পেক্ট্ৰ'স্কপিত আইচ'টপিক প্ৰতিস্থাপনৰ প্ৰভাৱ আলোচনা কৰা। বেনযিন চক্ৰৰ C—H বান্ধনিৰ নমন অনুকম্পনীয় কম্পনাংক 1192 cm^{-1}ত পোৱা গ'ল। যদি হাইড্ৰ'জেন পৰমাণুটো ডিউটেৰিয়াম পৰমাণুৰ দ্বাৰা প্ৰতিস্থাপন কৰা হয়, তেন্তে ইয়াৰ অনুকম্পনীয় কম্পনাংক কি হ'ব? 3+1=4

Discuss the effect of isotopic substitution in IR spectroscopy. The bending vibrational frequency of C—H bond of benzene ring is found at 1192 cm^{-1}. If the hydrogen atom is substituted with deuterium, what will be the vibrational frequency of the bond?

(Continued)

(iv) পাৰমাণৱিক শোষণ স্পেক্ট্ৰ'স্কপিত আয়নীয় হস্তক্ষেপ কি? ইয়াক কিদৰে নিয়ন্ত্ৰণ কৰিব পাৰি? 2+2=4

What is ionization interference in atomic absorption spectroscopy? How can the ionization interference be minimized?

(v) Jobsৰ ক্ৰমাগত পৰিৱৰ্তন পদ্ধতিৰ সহায়ত দ্ৰৱত গঠন হোৱা জটিল আয়নৰ গঠন-সংকেত কিদৰে নির্ণয় কৰা হয়? ব্যাখ্যা কৰা।

How can the composition of the complex ion formed in solution be determined by Jobs continuous variation method? Explain.

5. TGAৰ পৰীক্ষণীয় বিন্যাস আলোচনা কৰা। 3

Describe the experimental setup of TGA.

নাইবা / Or

এক ধাপযুক্ত ভৰ হ্ৰাস প্ৰক্ৰিয়াৰ বাবে এটা আদর্শ TG ৰেখা আৰু ইয়াৰ অনুৰূপ অৱকলন DTG ৰেখা অংকন কৰা। ৰেখাবোৰৰ বিভিন্ন অংশসমূহ চিনাক্ত কৰি চমুকৈ ব্যাখ্যা কৰা।

Sketch a typical TG curve and the corresponding derivative thermogravimetric (DTG) curve for single-step mass loss process. Label and briefly explain the different regions of the thermogravimetric curves.

(Turn Over)

6. *(a)* পৰিৱাহী কোষ এটাৰ 'কোষ ধ্ৰুৱক' কি? ইয়াৰ একক কি? 25 °C উষ্ণতাত 0·01 *M* KCl দ্ৰৱ যাৰ বিশিষ্ট পৰিৱাহিতা 0·001409 S cm^{-1} এটাৰ ৰোধকৰ মান 161·8 Ω। একেটা কোষৰ বাবে 0·005 *M* NaOH দ্ৰৱ এটাৰ ৰোধকৰ মান 190 Ω পোৱা গ'ল। কোষটোৰ কোষ ধ্ৰুৱক, NaOH দ্ৰৱৰ বিশিষ্ট পৰিৱাহিতা আৰু ম'লাৰ পৰিৱাহিতা নিৰ্ণয় কৰা। 1+1+3=5

What is 'cell constant' of a conductivity cell? What is its unit? A certain conductivity cell was filled with 0·01 *M* solution of KCl (whose specific conductance is 0·001409 S cm^{-1}) at 25 °C; a resistance of 161·8 Ω is recorded at the conductivity metre. When is the same cell filled with 0·005 *M* NaOH, its resistance is found to be 190 Ω . Calculate the cell constant, specific conductivity and molar conductivity of NaOH solution.

নাইবা / Or

(b) প্ৰমাণ হাইড্ৰ'জেন বিদ্যুৎদ্বাৰ (SHE)ৰ গঠন আৰু কাৰ্যপ্ৰণালী আলোচনা কৰা। ইয়াৰ সুবিধা আৰু অসুবিধাসমূহ উল্লেখ কৰা। 2+2+1=5

Discuss the construction and working principle of standard hydrogen electrode (SHE). Mention the advantages and disadvantages of SHE.

(Continued)

7. তলৰ যি কোনো দুটা প্ৰশ্নৰ উত্তৰ লিখা : 4×2=8

Answer any *two* questions from the following :

(a) জৈৱ যৌগৰ দ্ৰৱণীয়তা বৈশিষ্ট্য আৰু আম্লিক/ক্ষাৰকীয় ধৰ্মৰ ভিত্তিত এটা মিশ্ৰণৰ পৰা বিভিন্ন জৈৱ যৌগবোৰ কেনেকৈ পৃথক কৰিব পাৰি, উপযুক্ত উদাহৰণসহ ব্যাখ্যা কৰা।

Explain with suitable examples how we can separate different organic compounds from a mixture depending upon the solubility characteristics of these compounds and using acidic/ basic behaviour.

(b) অধিশোষণ আৰু বিভাজন বৰ্ণলেখনৰ পাৰ্থক্যসমূহ আলোচনা কৰা। অধিশোষণ আৰু বিভাজন বৰ্ণলেখনৰ একোটাকৈ উদাহৰণ দিয়া।

Discuss the differences between adsorption and partition chromatography. Give one example of adsorption and partition chromatography.

(c) স্তম্ভ বৰ্ণলেখনৰ দ্বাৰা মিশ্ৰণ এটাৰ উপাদানসমূহ পৃথকীকৰণ পদ্ধতিত isocratic elution আৰু gradient elution কি, আলোচনা কৰা।

Discuss the isocratic elution and gradient elution for separating the components of a mixture using column chromatography.

★★★

Total No. of Printed Pages—16

5 SEM TDC DSE PHY (CBCS)
2 (H) A/B/C

2022

(Nov/Dec)

PHYSICS

(Discipline Specific Elective)

(For Honours)

Paper : DSE–2

The figures in the margin indicate full marks for the questions

Paper : DSE–2 (A)

(Astronomy and Astrophysics)

Full Marks : 80
Pass Marks : 32

Time : 3 hours

1. Choose the correct answer from the following : 1×8=8

(a) One parsec is equal to

(i) $1 \cdot 496 \times 10^{11}$ m

(ii) $3 \cdot 085 \times 10^{16}$ m

(iii) $2 \cdot 062 \times 10^{8}$ AU

(iv) None of the above

(b) Which of the following statements about the celestial sphere is incorrect?

(i) The earth is placed at the centre of the celestial sphere.

(ii) The celestial sphere is just another name for our universe.

(iii) The celestial sphere does not exist physically.

(iv) When we look at the sky, the stars all appear to be located on the celestial sphere.

(c) The dimension of Hubble's constant is

(i) $[L]$

(ii) $[T^{-1}]$

(iii) $[MLT^{-2}]$

(iv) $[LT^{-1}]$

(d) The evolution of planets involves three stages in which of the following orders?

(i) Protoplanets, planetesimals, stabilization

(ii) Planetesimals, protoplanets, stabilization

(iii) Planetesimals, stabilization protoplanets

(iv) Stabilization, protoplanets, planetesimals

(e) The expansion of the universe is explained by

(i) virial theorem

(ii) Hubble's law

(iii) nebular theory

(iv) helioseismology

(f) The hottest layer of the solar atmosphere is

(i) photosphere

(ii) corona

(iii) chromosphere

(iv) transition region

(g) In lenticular galaxies, which of the following is not correct?

(i) They have a bulge and a disk

(ii) Disk does not contain spiral arms

(iii) Disk contains spiral arms

(iv) None of the above

(h) The sun is located in the Milky Way galaxy about _____ from the galactic centre of the galaxy.

(i) 1000 pc

(ii) 8000 pc

(iii) 28000 pc

(iv) 10 kpc

2. Answer any *eight* of the following : 2×8=16

(a) What are circumpolar stars?

(b) Differentiate between the terms 'absolute magnitude' and 'apparent magnitude' of a star.

(c) The apparent magnitudes of two stars are 0·06 and 1·06 respectively. Calculate the ratio of their brightness.

(d) What are atmospheric windows?

(e) The surface temperature of two stars *A* and *B* is the same and the luminosity of *A* is higher than *B*. Which of the two stars is bigger in size? Why?

(f) Define luminosity.

(g) Define elliptical galaxy.

(h) What is galactic halo?

(i) What is dark matter?

3. Answer any *three* of the following : 5×3=15

(a) Describe how the masses are determined in a binary star system.

(b) Discuss any one coordinate system used in astronomy.

(Continued)

(c) Define sidereal time. Explain why a sidereal day is shorter than the solar day. What do you mean by solar time? 1½+2+1½=5

(d) Write about the equation of time (ET) and draw the variation of ET during the year.

4. Answer any *two* of the following : 4×2=8

(a) Discuss, with neat diagram, the equatorial mounting system of telescope.

(b) Estimate the radius of a star in thermal equilibrium of mass 10^{30} kg and average internal temperature 10^{7} K. It is given that

$$k_B = 1{\cdot}38 \times 10^{-23}\ \text{J K}^{-1}$$

$$m_H \sim 1{\cdot}67 \times 10^{-27}\ \text{kg}$$

$$G = 6{\cdot}7 \times 10^{-11}\ \text{m kg}^{-1}\text{s}^{-2}$$

(c) Write a short note on virial theorem.

5. *(a)* Describe the Hertzsprung-Russell diagram. 4

(b) Discuss about spectral classification of stars. Also, explain its dependence on stellar temperature. 4

(Turn Over)

6. *(a)* What are the different layers of the solar atmosphere? What is coronal heating problem? 3+2=5

Or

Discuss briefly the theory of the solar system formation based on nebular hypothesis. 5

(b) What is exoplanet? Explain how extra-solar planets can be detected. 1+2=3

7. *(a)* Explain Hubble's tuning fork diagram with a neat sketch. 3+2=5

Or

Describe the Milky Way morphology. 5

(b) Describe the rotation curve for a galaxy. 3

Or

State and explain de Vancouver's law.

8. *(a)* Explain Hubble's law along with the velocity-distance plot. 2+1=3

(b) What is cosmic distance ladder technique? Give an example of a cosmic distance ladder technique and explain its working. 3+3=6

Paper : DSE–2 (B)

(Physics of Devices and Instruments)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

1. Choose the correct answer from the following : 1×5=5

(a) The terminals of a unijunction transistor are

(i) collector, base and emitter

(ii) emitter, base 1 and base 2

(iii) gate, drain and source

(iv) gate, drain, body and source

(b) The voltage regulator IC7905 provides regulated output voltage equal to

(i) 78 volt

(ii) +5 volt

(iii) 12 volt

(iv) –5 volt

(c) Which semiconductor is most widely used for fabrication of integrated circuit?

(i) Germanium

(ii) Gallium arsenide

(iii) Silicon

(iv) None of the above

(d) GPIB stands for

(i) General Purpose Interface Bus

(ii) General Purpose Institute Bus

(iii) General Parallel Institute Bus

(iv) General Parallel Interface Bus

(e) Which of the following parameters is varied in amplitude-modulated wave?

(i) Frequency

(ii) Phase

(iii) Amplitude

(iv) None of the above

2. Answer the following questions : 2×5=10

(a) Differentiate between depletion and enhancement mode MOSFET.

(b) What are positive and negative masks?

(c) Explain the basic idea of UART.

(d) Write the basic idea of sending data through a COM port.

(e) Why is modulation required in communication system?

3. (a) Explain the characteristics and small signal equivalence of JFET. What is metal semiconductor junction? 4+2=6

Or

Discuss the construction and working of D-MOSFET with diagram. What is charge-coupled device? 4+2=6

(b) Draw the *I-V* characteristic curve of a tunnel diode and explain. 3

4. Draw the block diagram of a power supply and explain its operation. Explain the action of shunt capacitor in a rectifier circuit as filter. What are load and line regulations? 4+2+2=8

Or

What are active and passive filters? Explain constant-*k* low-pass filter with circuit diagram. Write the limitation of constant-*k* filter. 4+2+2=8

5. Explain the basic principle of phase-locked loop (PLL) with circuit diagram. Draw and label the PLL IC 565. 4+1=5

Or

Explain the working of a voltage-controlled oscillator (VCO). What is loop filter? 4+1=5

6. *(a)* Discuss the basic steps involved in integrated circuit fabrication process. 4

Or

Discuss briefly about defects in the lattice.

(b) Write a short note on optical lithography or metallization techniques. 3

7. *(a)* Derive the equation and power relation for an AM wave. Compare AM and FM. 4+2=6

Or

Explain the demodulation of AM wave using diode detector with circuit diagram. Define modulation index of AM wave. 4+2=6

(b) Compare ASK and PSK. 3

Paper : DSE–2 (C)

(Physics of Earth)

Full Marks : 80
Pass Marks : 32

Time : 3 hours

1. Choose the correct answer/Fill in the blank from the following (any *eight*) : 1×8=8

(a) Milky Way is a/an

(i) peculiar galaxy

(ii) irregular galaxy

(iii) elliptical galaxy

(iv) spiral galaxy

(b) The hydrosphere is the mass of water found

(i) on the surface of the earth

(ii) below the surface of the earth

(iii) both on and below the surface of the earth

(iv) None of the above

(c) Freshwater accounts for _____ of the water on the earth.

(i) 2·5%

(ii) 5%

(iii) 7·5%

(iv) 10%

(d) What is the point on the earth's surface directly above an earthquake form?

(i) Earthquake centre

(ii) Epicentre

(iii) Fault

(iv) Focus

(e) Volcanoes are associated with all of the following areas, *except*

(i) rift zone

(ii) epicentre

(iii) subduction zone

(iv) hot spots

(f) The combined portion of the earth in which all living things exist is called

(i) biome

(ii) ecosystem

(iii) community

(iv) biosphere

(g) Eons and eras are units of _____.

(h) What is the atmospheric layer closest to the ground?

(i) Mesosphere

(ii) Troposphere

(iii) Thermosphere

(iv) Stratosphere

(i) Gravitational force is _____ (strongest/ weakest) at the centre of the earth.

(j) Photosynthesis, decomposition, respiration and combustion are the four steps of

(i) water cycle

(ii) nitrogen cycle

(iii) carbon cycle

(iv) phosphorus cycle

2. Answer the following questions :

(a) What are meteorites and asteroids? What are terrestrial and Jovian planets? 1½+1½=3

(b) Discuss the rotational and revolution parameters of the earth. 2+2=4

(c) Explain the origin of cosmic microwave background and its relationship to the Big Bang. 5

(d) Discuss about energy and particle fluxes incident on the earth. 5

Or

Describe the different stages of formation of a planet.

3. Answer the following questions :

(a) Define geothermal energy and mention three main uses of it. 1½+1½=3

(b) What do you mean by cryosphere? How are glacier ice sheets and polar ice caps formed? 1+3=4

(c) What are the main three layers of the earth? What do you mean by continental and oceanic crust? Mention three most common elements of the earth's crust. 1+2+2=5

(d) Discuss the variation of temperature, density and composition of the atmosphere with altitude. 5

Or

Discuss, in detail, three basic components of the biosphere.

4. Answer the following questions :

(a) What do you mean by seafloor spreading? Explain how convection currents may be related to plate tectonics. 1+2=3

(b) What are tides and how are they useful? What happens, when a tsunami enters shallow water? 2+2=4

(c) What causes earthquakes? Compare and contrast primary, secondary and surface waves. Define Richter scale. 1+3+1=5

(d) How do volcanoes form? Discuss about different types of volcanoes and their products and distribution. 1+4=5

Or

Write a short note on water cycle. 5

5. Answer the following questions :

(a) Discuss the principle of uniformitarianism. 3

(b) Give a brief discussion on nebular and catastrophic hypotheses on the origin of the earth. 2+2=4

(c) Define geological timescale. Discuss about some major geological events. 1+4=5