6 SEM TDC MTMH (CBCS) C 13

2022

(June/July)

MATHEMATICS

(Core)

Paper : C–13

(Metric Spaces and Complex Analysis)

Full Marks : 80
Pass Marks : 32

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. *(a)* Every non-empty set can be regarded as a metric space. State true or false. 1

(b) Write when a metric is called a discrete metric. 1

(c) Write the definition of an open set in metric space. 2

(d) Define complete metric space. 2

(e) If (X, d) is a metric space and $x, y, z \in X$ be any three distinct points, then show that $d(x, y) \geq |d(x, z) - d(z, y)|$. 4

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

(i) Prove that in any metric space X, each open sphere is an open set.

(ii) Let X be any non-empty set and d a function defined on X, such that $d : X \times X \to R$ defined by

$$d(x, y) = 0 \text{ , if } x = y$$
$$= 1 \text{ , if } x \neq y$$

Prove that d is a metric on X.

(iii) If (X, d) be a metric space and $\{x_n\}$, $\{y_n\}$ are sequences in X such that $x_n \to x$ and $y_n \to y$, then show that

$$\{d(x_n, y_n)\} \to d(x, y)$$

(iv) Prove that the limit of a sequence in a metric space, if it exists, is unique.

2. (a) Real line R is not connected. State true or false. 1

(b) Write one property of continuous mapping. 1

(c) Write the definition of uniform continuity in a metric space. 2

(Continued)

(d) Write the statement of fixed point theorem. 2

(e) Write the definition of contracting mapping. 3

(f) Show that homeomorphism on the set of all metric spaces is an equivalence relation. 6

Or

Let X and Y be metric spaces and f a mapping of X into Y. Show that f is continuous at x_0 if and only if $x_n \to x_0 \Rightarrow f(x_n) \to f(x_0)$.

3. (a) If $(a, b) = a(1, 0) + b(0, 1)$, then write the value of $(0, 1)(0, 1)$. 1

(b) Write an example of a multiple valued function of a complex variable. 1

(c) Define derivative of a function of complex variable. 2

(d) Write the Cauchy-Riemann equations in polar form. 2

(e) Show that $\lim_{z \to 0} \frac{\bar{z}}{z}$ does not exist. 4

Or

Show that $|z_1 z_2|^2 = |z_1|^2 |z_2|^2$.

(Turn Over)

(f) Prove that $f(z) = z^2 + 2z + 3$ is continuous everywhere in the finite plane. 5

Or

Prove that if $w = f(z) = u + iv$ is analytic in a region R, then

$$\frac{dw}{dz} = \frac{\partial w}{\partial x} = -i\frac{\partial w}{\partial y}$$

4. (a) Define an analytic function at a point. 1

(b) Write the interval of θ in the principal value of $\log z = \log r + i\theta$. 1

(c) Write $\sinh z$ in terms of exponential functions. 1

(d) Write the value of $\int_C dz$ where C is a closed curve. 1

(e) Show that the function $f(z) = e^{x+iy}$ is analytic. 4

(f) Find

$$\int_0^1 ze^{2z}dz$$ 4

Or

Evaluate $\int_C \bar{z}\,dz$ from $z = 0$ to $z = 4 + 2i$ along the curve C given by $z = t^2 + it$.

5. (a) Obtain Taylor's series for the function

$$f(z) = \frac{(z-2)(z+2)}{(z+1)(z+4)}$$

when $|z| < 1$. 4

(b) State and prove Liouville's theorem. 6

Or

Prove that the series

$$z(1-z) + z^2(1-z) + z^3(1-z) + \cdots$$

converges for $|z| < 1$.

6. (a) Write the statement of Laurent's theorem. 2

(b) Expand

$$f(z) = \frac{1}{(z+1)(z+3)}$$

in a Laurent series valid for $1 < |z| < 3$. 6

Or

Prove that the sequence $\left\{\frac{1}{1+nz}\right\}$ is uniformly convergent to zero for all z such that $|z| \geq 2$.

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Total No. of Printed Pages—7

6 SEM TDC PHYH (CBCS) C13

2022

(June/July)

PHYSICS

(Core)

Paper : C–13

(Electromagnetic Theory)

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 (any *five*) : 1×5=5

(a) The displacement current arises due to

(i) positive charges only

(ii) negative charges only

(iii) both positive and negative charges

(iv) time varying electric field

(b) An electromagnetic wave travells along z-axis. Which of the following pairs of space and time varying fields would generate such a wave?

(i) E_x, B_y

(ii) E_y, B_x

(iii) E_z, B_x

(iv) E_y, B_z

(c) Considering the reflection and refraction of a plane wave at a dielectric interface, which of the following is true?

(i) The energy of the wave does not change

(ii) The frequency of the wave does not change

(iii) The polarization does not change

(iv) The momentum of the wave does not change

(d) A plane polarized monochromatic electromagnetic wave incident on a plane interface at the Brewster angle gives rise to a reflected wave, which is

(i) partially polarized

(ii) unpolarized

(iii) polarized parallel to the interface

(iv) polarized perpendicular to the interface

(e) The energy of e.m. wave in vacuum is given by the relation

(i) $\frac{E^2}{2\varepsilon_0}+\frac{B^2}{2\mu_0}$

(ii) $\frac{1}{2}\varepsilon_0 E^2+\frac{1}{2}\mu_0 B^2$

(iii) $\frac{E^2+B^2}{C}$

(iv) $\frac{1}{2}\varepsilon_0 E^2+\frac{B^2}{2\mu_0}$

(f) The ratio of electric field vector $\vec{E}$ and magnetic field vector $\vec{H}$ (i.e., $\vec{E}/\vec{H}$) has the dimension of

(i) inductance

(ii) resistance

(iii) capacitance

(iv) product of inductance and capacitance

2. Answer the following (any *five*) : 2×5=10

(a) Define scalar and vector potential.

(b) Distinguish between Lorentz gauge and Coulomb gauge.

(c) What are the peculiarities of metallic reflection?

(d) What are ordinary and extra-ordinary refractive indices?

(e) What are Fresnel's equations for reflection of plane polarized light from transparent media?

(f) Define single and multimode fibre.

3. (a) State and prove Poynting theorem related to the flow of energy at a point space in an electromagnetic field. What is physical significance of Poynting vector? 1+5+1=7

Or

Show that for an electromagnetic field, the energy density

$$U = \frac{1}{2}(\varepsilon_0 E^2 + \mu_0 H^2)$$ 7

(b) Write Maxwell's equations in differential form and discuss the physical significance. 4

4. (a) Starting from Maxwell's equations, discuss the plane electromagnetic waves in a dielectric isotopic medium. 7

Or

Discuss the phenomena of total internal reflection on the basis of electromagnetic theory of light.

(b) Discuss in detail how two electromagnetic waves combine to form—

(i) elliptically polarized light;

(ii) circularly polarized light. 7

5. What is waveguide? Describe the propagation of electromagnetic wave along a hollow waveguide of uniform cross section. Explain, how cutoff mode arises. 2+2+1=5

Or

For transverse electric waves perfectly propagating in a rectangular waveguide with perfectly conducting walls, find—

(a) the cutoff wavelength;

(b) the velocity with which energy is transmitted along the guide. 5

(Continued)

6. Write short notes on (any *two*) : 4×2=8

(a) Skin depth

(b) Brewster's law

(c) Nicol prism

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Total No. of Printed Pages—3

6 SEM TDC ZOOH (CBCS) C 13

2022

(June/July)

ZOOLOGY

(Core)

Paper : C–13

(Developmental 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) Avian egg is _____.

(b) Mammals in which true placenta is present are called _____.

(c) At the end of gastrulation, _____ movements start.

(d) The embryonic tissue that influences other tissues to differentiate is known as _____.

(e) The pituitary hormone _____ is involved as an inhibitor in the overall control of metamorphosis.

2. Distinguish between the following pairs (any *two*) : 2×2=4

(a) Fertilizin and Antifertilizin

(b) Epiboly and Emboly

(c) Area pellucida and Area opaca

3. Write short notes on the following (any *two*) : 5×2=10

(a) Regeneration

(b) Stem cell

(c) Ageing

4. What do you mean by fertilization? Discuss how sperm approaches towards egg during fertilization. 2+8=10

Or

What is cleavage? Discuss briefly the patterns of cleavage with examples. 2+8=10

5. What are extra-embryonic membranes? Discuss the structure and functions of extra-embryonic membranes found in chick. 2+10=12

Or

Define placenta. Classify the different types of placenta. What are its functions? 2+6+4=12

6. What is ontogenetic development? Discuss the different phases of ontogenetic development. 2+10=12

Or

What is 'gametogenesis'? Describe the process of 'oogenesis' in detail. What type of cytoplasmic changes occur during the formation of a mature oocyte? 2+7+3=12

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6 SEM TDC CHMH (CBCS) C 13

2022

(June/July)

CHEMISTRY

(Core)

Paper : C–13

(Inorganic 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 from the following : 1×7=7

(a) In the complex $(\sigma\text{-}C_3H_5)Re(CO)_5$, the allyl group is

(i) monohapto ligand

(ii) dihapto ligand

(iii) trihapto ligand

(iv) pentahapto ligand

(b) The stretching wave number of CO molecule is $2143\,cm^{-1}$. The C—O stretching wave number of CO in $Ni(CO)_4$ is

(i) $2060\,cm^{-1}$

(ii) $2160\,cm^{-1}$

(iii) $2260\,cm^{-1}$

(iv) $2243\,cm^{-1}$

(c) Which of the following complexes does not obey $18\,e^-$ rule?

(i) $Fe(\eta_5\text{-}C_5H_5)_2$

(ii) $Cr(\eta_3\text{-}C_5H_5)_2$

(iii) $Co_2(CO)_8$

(iv) $Fe(CO)_4PPh_3$

(d) Which of the following has minimum *trans*-effect?

(i) C_2H_4

(ii) NO_2^-

(iii) NH_3

(iv) Br^-

(e) Which of the following combinations of basic radicals belongs to group IV?

(i) Zn, Co, Ni

(ii) Zn, Co, Mg

(iii) Zn, Ni, Hg

(iv) Mn, Ni, Pb

(f) What is the chemical form of the precipitates of group V?

(i) Chloride

(ii) Sulphide

(iii) Hydroxide

(iv) Carbonate

(g) Which of the following complexes is called Wilkinson's catalyst?

(i) $RhCl(PPh_3)_3$

(ii) $Ir(CO)Cl(PPh_3)_2$

(iii) $HCo(CO)_4$

(iv) $Zr(CH_3)ClPh_2$

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

(a) How does a precipitation occur in solution during salt analysis? Why is H_2S passed in acidic medium for the precipitation of group II basic radicals? 1+1=2

(b) Give an example of reaction in which $HCo(CO)_4$ is used as catalyst. 2

(c) What is *trans*-effect? Write down the *trans*-series. 1+1=2

(d) Give one method of preparation of each of the following : 2

(i) Zeise's salt

(ii) Ferrocene

(e) Assuming 18-electron rule is valid, find the number of metal-metal bonds in metal carbonyls $Fe_3(CO)_{12}$ and $Co_4(CO)_{12}$. 2

(f) What are labile and inert complexes? Explain with examples. 2

UNIT—I

3. Answer any *two* from the following questions : 3×2=6

(a) What is common-ion effect? Discuss the application of common-ion effect in the qualitative analysis of inorganic salt. 1+2=3

(b) Explain why concentrated HCl is used in the flame test for basic radicals. Whether flame test can be done for a salt having Cu^{2+} ion in presence of BO_3^{3-} acid radicals? 1½+1½=3

(c) What is solubility product? Explain why during the precipitation of group III NH_4OH is added in presence of NH_4Cl. 1+2=3

UNIT—II

4. Answer any *four* from the following questions : 3×4=12

(a) Outline the synthesis of a low nuclearity carbonyl cluster. Discuss the structure of the cluster. 1+2=3

(b) Draw the MO energy level diagram of CO molecule and discuss its π-accepting ability. 2+1=3

(c) What is 18-electron rule? How is 18-electron rule helpful in determining the number of metal-metal bonds in metal carbonyl compounds? 1+2=3

(d) Discuss the structure and bonding in Zeise's salt. 3

(e) Discuss the role of triethyl aluminium in the polymerization of ethane. 3

(f) Discuss the bonding in ferrocene with the help of MOT. 3

UNIT—III

5. Answer any *four* from the following questions : 3×4=12

(a) Discuss the mechanism of the following reaction : 3

$$[Co(NH_3)_5Cl]^{2+} \xrightarrow[-Cl^-]{slow}$$

$$[Co(NH_3)_5]^{3+} \xrightarrow[+H_2O]{fast} [Co(NH_3)_5H_2O]^{3+}$$

(b) A thermodynamically stable complex may not be kinetically stable. Explain. 3

3.

(c) Discuss the effects of the following factors on the rate of hydrolysis of octahedral complex : 1½×2=3

(i) Charge on the substrate

(ii) Steric effect

(d) Starting from $[PtCl_4]^{2-}$ and other ligands, outline the synthesis of *cis*- and *trans*-$[PtCl_2(NH_3)(NO_2)]$. 3

(e) Discuss the base hydrolysis reaction of a cobalt complex. 3

UNIT—IV

6. Answer any *two* from the following questions : 3×2=6

(a) Give the reaction path of the hydrogenation of olefin with the help of Wilkinson's catalyst. 3

(b) Discuss the route of hydroformylation reaction catalyzed by $HCo(CO)_4$. Mention the oxidation and insertion steps during the course of the reaction. 2+1=3

(c) Discuss Wacker process of oxidation of ethylene. 3

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Total No. of Printed Pages—3

6 SEM TDC BOTH (CBCS) C 13

2022

(June/July)

BOTANY

(Core)

Paper : C–13

(Plant Metabolism)

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 : 1×3=3

(i) In photosynthesis, oxygen is liberated due to

(1) reduction of CO_2

(2) photolysis of water

(3) hydrolysis of carbohydrate

(4) breakdown of chlorophyll

(ii) In root nodule of legumes, leg hemoglobin is found in

(1) bacteroids

(2) cytosol of infected nodule cell

(3) cytosol of uninfected nodule cell

(4) All of the above

(iii) The net gain of ATP molecules in glycolysis is

(1) 0

(2) 2

(3) 4

(4) 8

(b) Fill in the blanks : 1×2=2

(i) All photosynthetic pigments except chlorophyll-a are called _____.

(ii) The process of conversion of ammonia into nitrate is called _____.

2. Write short notes on the following : 4×3=12

(a) Covalent modulation

(b) Photosynthetic pigments

(c) Factors affecting respiration

3. Write explanatory notes on any *two* of the following : 6×2=12

(a) β-oxidation of fatty acids

(b) Chemiosmotic mechanism of ATP synthesis

(c) Synthesis and degradation of sucrose

(d) Plant cell signal transduction

4. Describe schematically the pentose phosphate pathway of glucose oxidation. What is its significance? 9+3=12

Or

Differentiate between anabolism and catabolism. Explain the pathways of anabolism and catabolism. How can the pathway be regulated? 2+8+2=12

5. What are the chief sources of nitrogen for higher plants? Describe the mechanism of nitrogen fixation by free living and symbiotic bacteria. Explain the ecological significance of this process. 2+7+3=12

Or

What is 'dark reaction' in photosynthesis? Dscribe the mechanism of dark reaction in C_3 plants. 2+10=12

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Total No. of Printed Pages—3

6 SEM TDC BOTH (CBCS) C 14

2022

(June/July)

BOTANY

(Core)

Paper : C–14

(Plant Biotechnology)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

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

(a) Define totipotency.

(b) What is GMO?

(c) Define embryogenesis.

(d) What is cryopreservation?

(e) Who is known as the father of tissue culture?

2. Write notes on/Answer any *five* of the following : 2×5=10

(a) Protoplast fusion

(b) Transgenic crop

(c) Cloning vectors

(d) Bt cotton

(e) Cosmid vector

(f) Define microinjection.

3. Write short notes on any *four* of the following : 5×4=20

(a) Composition of media for tissue culture

(b) Restriction endonuclease

(c) PCR-mediated gene cloning

(d) Role of transgenesis in bioremediation

(e) Shuttle vector

4. Discuss about the various methods of gene transfer. 8

Or

Describe about the recombinant DNA technology.

5. Describe the tissue culture technique. What are applications of plant tissue culture? 5+5=10

Or

Discuss about the application of biotechnology with special reference to agriculture, horticulture, bioremediation, enzymology and pharmaceuticals. 10

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Total No. of Printed Pages—5

6 SEM TDC PHYH (CBCS) C 14

2022

(June/July)

PHYSICS

(Core)

Course : C–14

(Statistical Mechanics)

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) In the equilibrium state, the thermodynamic probability of a system is

(i) zero

(ii) maximum

(iii) minimum but not 1

(iv) one

(b) Gibbs' paradox arises due to

(i) indistinguishability of classical particles

(ii) distinguishability of classical particles

(iii) omittance of quantum nature of the particles

(iv) absence of inter-particle interaction

(c) Rayleigh-Jeans law agrees well with the experimental result at

(i) low frequency

(ii) infinity

(iii) high frequency

(iv) None of the above

(d) At high temperature, Bose-Einstein distribution approaches Maxwell-Boltzmann distribution.

(i) False

(ii) True

(iii) Cannot say

(iv) Sometimes true sometimes false

(e) From Fermi-Dirac statistics, $n_i = ?$

(i) $\frac{g_i}{e^{\alpha+\beta\varepsilon_i}+1}$ (ii) $\frac{2g_i}{e^{\alpha+\beta\varepsilon_i}+1}$

(iii) $\frac{g_i}{e^{\alpha+\beta\varepsilon_i}-1}$ (iv) $\frac{2g_i}{e^{\alpha+\beta\varepsilon_i}-1}$

2. (a) Define and explain in brief the terms 'macrostate' and 'microstate' with the help of an example. 2+2=4

(b) Define entropy. Deduce Boltzmann's entropy relation. 1+3=4

(c) Treating the ideal gas as a system governed by classical mechanics, derive the Maxwell-Boltzmann distribution law. 6

Or

Derive the partition function for an ideal monoatomic gas.

3. (a) What do you mean by 'thermal radiation'? 2

Or

If the sun emits maximum energy at wavelength 4753 Å, then calculate the temperature of its surface. (Given : Wien's constant $b = 0 \cdot 288$ cm °C)

(b) State and prove Kirchhoff's law of blackbody radiation. 4

(c) State and derive Planck's law of black-body relation. 1+4=5

Or

State Stefan-Boltzmann law of radiation. Deduce this law on thermodynamic consideration. 5

4. *(a)* What is photon gas? What is the difference between photon gas and ideal gas? 1+2=3

(b) What is Bose-Einstein statistics? Derive an expression

$$n_i = \frac{g_i}{e^{\alpha+\beta\varepsilon_i} - 1}$$ 1+3=4

Or

Explain why behavior of liquid helium cannot be explained by classical statistics. How is it overcome by quantum mechanics? 4

(c) Bosons may condense at very low temperature. Discuss on the basis of statistical mechanics. 4

5. *(a)* At absolute zero temperature ($T = 0$ K) all the energy levels up to ε_f are completely filled. Calculate the total number of fermions in a Fermi gas at $T = 0$ K and express ε_f in terms of number density (N/V). 6

Or

Derive an expression for Fermi-Dirac law of energy distribution for free electrons in a metal.

(b) What is the cause of degeneracy pressure inside a white dwarf star? Explain the limit depending on which some stars become white dwarf and other become neutron star or black hole. 1+5=6

Or

A system has 7 particles arranged in two compartments. The first compartment has 8 cells and the second has 10 cells. All cells are of equal size. Calculate the number of microstate in the micro-state (3, 4) when the particles obey F-D statistics. 6

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6 SEM TDC ZOOH (CBCS) C 14

2022

(June/July)

ZOOLOGY

(Core)

Paper : C–14

(Evolutionary Biology)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Select the correct answer : 1×5=5

(a) Mesozoic era is called the age of

(i) Fishes

(ii) Mammals

(iii) Reptiles

(iv) Birds

(b) The modern view of Natural Selection refers to the

(i) differential death

(ii) differential survival

(iii) differential struggle

(iv) differential reproductive success

(c) An isolating mechanism that prevents successful fertilization is called

(i) zygote mortality

(ii) pre-zygote mechanism

(iii) post-zygote mechanism

(iv) hydrid sterility

(d) Variation is a phenomenon at

(i) species level

(ii) population level

(iii) genetic level

(iv) geographic level

(e) The neutral theory states that

(i) selection at molecular level is neutral and does not have any effect on individual fitness

(ii) the evolutionary theories are all neutral in sense

(iii) the natural selection force is by and large neutral on all the individuals in the nature

(iv) None of the above

2. Write short notes on (any *two*) : 4×2=8

(a) Neo-Darwinism

(b) Founder's effect on origin of new species

(c) Biological species concept

(d) Density-dependent selection

(e) Phylogenetic tree

3. What is fossil? Describe the types of fossil and their significance in evolutionary biology. 1+3+4=8

Or

What is geological time scale? Describe about the characteristic of Cenozoic era. 8

4. What is variation and its significance? Describe the different types of variation. 2+6=8

Or

Write a note on heritable variations. Describe the role of heritable variation in evolution. 2+6=8

5. Describe Hardy-Weinberg's law and its application. Write a brief note on gene pool. 3+5=8

Or

Discuss how genetic drift and migration affect genetic equilibrium in a population. 8

6. Describe about allopatric and sympatric types of speciation with suitable examples. 8

Or

Describe briefly about the mechanism of adaptive radiation with suitable example.

7. Discuss about the effect of mass extinction. Mention unique characteristic of hominins. 8

Or

Discuss about the abiogenesis of simple organic molecules on the primitive earth atmosphere.

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Total No. of Printed Pages—8

6 SEM TDC CHMH (CBCS) C 14

2022

(June/July)

CHEMISTRY

(Core)

Paper : C–14

(Organic Chemistry)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

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

(a) When the λ_{max} of a compound shifts to a shorter wavelength on certain treatment, the compound is said to have undergone

(i) bathochromic shift

(ii) hypochromic effect

(iii) hyperchromic shift

(iv) hypsochromic shift

(b) Dyes which can be applied directly to cotton from water solution are called

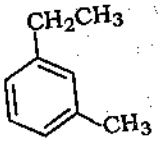
(i) mordant dyes

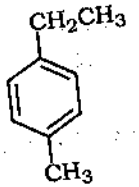
(ii) vat dyes

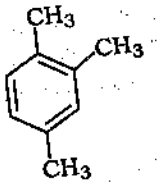
(iii) sustentive dyes

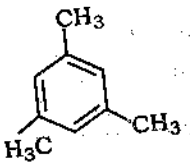
(iv) dispersive dyes

(c) The NMR spectrum of the compound C_9H_{12} shows two signals at $\tau 3 \cdot 22$(s, 3*H*) and $7 \cdot 75$(s, 9*H*). Which of the following structures is in conformity with the data?

(i) 

(ii) 

(iii) 

(iv) 

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(d) The monomers of Buna-S rubber are

(i) isoprene and butadiene

(ii) styrene and butadiene

(iii) adipic acid and hexamethylene diamine

(iv) chloroprene

(e) Epimeric carbohydrates differ in their

(i) configuration at α-C atom

(ii) number of —OH groups

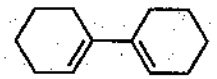
(iii) ring size

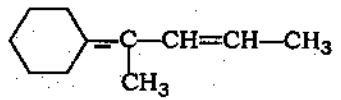
(iv) None of the above

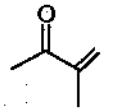
UNIT—I

2. Answer the following questions :

(a) Calculate λ_{max} in UV spectrum for the following : 1×3=3

(i) 

(ii) 

(iii) 

(Turn Over)

(b) Account for the following observations : 2×2=4

(i) Ethylene is colourless, but a polyene, e.g., $CH_3(CH{=}CH)_6CH_3$ is yellow.

(ii) 1,4-pentadiene does not absorb light above 200 nm.

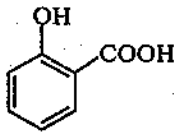
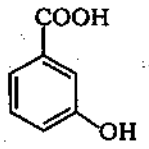
(c) Pent-1-ene absorbs at 176 nm. The absorption data, λ_{max} for three isomeric dienes *A*, *B* and *C* of molecular formula C_5H_8 is 178 nm, 211 nm and 215 nm respectively. Write down the structures of *A*, *B* and *C* with proper reasoning. 2

Or

Using MO theory, account for the following trends in λ_{max} (nm) :

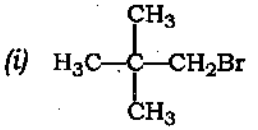
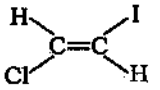
Ethylene (175), 1,3-butadiene (217) and 1,3,5,-hexatriene (250)

(d) How will you differentiate between the following pairs of compounds using IR spectra? 1½×2=3

(i)  and 

(ii) CH_3CH_2CHO and $H_2C{=}\underset{H}{C}{-}CH_2OH$

(e) What will be the multiplicity of each kind of proton in the following molecules? 2

(i)  (ii) 

(f) A compound, $C_9H_{10}O_2$, shows the following signals in ^{1}HNMR spectrum :

(i) δ2·3(3*H*, singlet)

(ii) δ3·6(3*H*, singlet)

(iii) δ6·4-7·5(4*H*, a pair of doublets J = 8 Hz)

Assign a structure to the compound. 3

(g) Identify the compound by analyzing the following data : 2

IR ν(cm^{-1}) : 1600, 1715, 3000

Mass (*m*/*e*) : 43, 91, 134 (M^+)

NMR δ value : 2·1(s, 3*H*), 3·6(s, 2*H*), 7·3(*m*, 5*H*)

(h) Explain the effect of polar solvent on π-π^* and n-π^* transitions. 2

Or

Why is TMS used as a reference in NMR spectroscopy?

UNIT—II

3. Answer the following questions :

(a) Establish the cyclic structure of D-glucose. 2

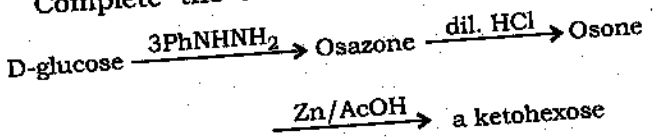
Or

Explain why D-glucose and D-fructose give the same osazone.

(b) What is epimerization? Explain it considering the conversion of D-glucose to D-mannose. 1+2=3

(c) Why does the anomeric —OH group undergo methylation with CH_3OH and HCl under reflux but others do not? 2

(d) Complete the following reaction : 3



UNIT—III

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

(a) What are the requirements of a substance to act as a dye? Name two substances which meet these requirements.

(Continued)

(b) How will you synthesize fluorescein?

(c) How would you prepare Congo red from naphthionic acid? Discuss its use as acid-base indicator.

(d) What are the chromophores and auxochromes present in the following dyes?

(i) Alizarin

(ii) Methyl orange

(e) Give one example of a xanthene dye and mordant azo dye. Also write their structures.

UNIT—IV

5. Answer the following questions :

(a) What is Ziegler-Natta catalyst? Discuss their importance in the formation of addition polymer. 2

(b) What type of alkenes prefer to undergo cationic polymerization? Discuss the role of electron donating groups in cationic polymerization. 1+2=3

Or

Discuss the mechanism of a peroxide-initiated chain growth polymerization involving any vinyl monomer. 3

(Turn Over)

(c) What do you understand by the term 'biodegradable polymers'? Give two examples. 1+1=2

(d) How would you prepare the following (any *one*)? 2

(i) Neoprene

(ii) Nylon-6

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6 SEM TDC MTMH (CBCS) C 14

2022

(June/July)

MATHEMATICS

(Core)

Paper : C–14

(Ring Theory and Linear Algebra–II)

Full Marks : 80
Pass Marks : 32

Time : 3 hours

The figures in the margin indicate full marks for the questions

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

(a) State and prove division algorithm for $F[x]$, where F is a field. 5

(b) Define principal ideal domain (PID). If F is a field, then show that $F[x]$ is a principal ideal domain. 1+4

(c) Define irreducible polynomial and write an example. Let F be a field. If $f(x) \in F(x)$ and deg $f(x) = 2$ or 3, then show that $f(x)$ is reducible over F if and only if $f(x)$ has a zero in F. 2+3

(d) In $Z[\sqrt{-5}]$, prove that $1+3\sqrt{-5}$ is irreducible but not prime. 5

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

(a) State and prove Eisenstein's criterion. 5

(b) Prove that a polynomial of degree n over a field has atmost n zeros counting multiplicity. 5

(c) Define unique factorization domain (UFD). Show that the ring $Z[\sqrt{-5}] = \{a+b\sqrt{-5} \mid a, b \in Z\}$ is an integral domain but not unique factorization domain. 1+4

(d) Define Euclidean domain. Prove that every Euclidean domain is a principal ideal domain. 1+4

3. Answer any *three* from the following : 6×3=18

(a) Suppose that V is a finite dimensional vector space with ordered basis $\beta = \{x_1, x_2, \cdots, x_n\}$. Let $f_i (1 \le i \le n)$ be the ith co-ordinate function with respect to β be defined such that $f_i(x_j) = \delta_{ij}$, where δ_{ij} is the Kronecker delta. Let $\beta^* = \{f_1, f_2, \cdots, f_n\}$. Then prove that β^* is an ordered basis for V^*, and for any $f \in V^*$, we have $f = \sum_{i=1}^{n} f(x_i) f_i$.

(b) For

$$A = \begin{bmatrix} 5 & -6 & -6 \\ -1 & 4 & 2 \\ 3 & -6 & -4 \end{bmatrix} \in M_{3\times 3}(R)$$

determine the eigenvalues of A and eigenspace of one eigenvalue of A.

(c) Let T be a linear operator on a finite dimensional vector space V. If f is the characteristic polynomial for T, then prove that the minimal polynomial divides the characteristic polynomial f for T.

(d) Find the characteristic polynomial and minimal polynomial for the real matrix

$$A = \begin{bmatrix} 7 & 4 & -1 \\ 4 & 7 & -1 \\ -4 & -4 & 4 \end{bmatrix}$$

Also show that the minimal polynomial divides the characteristic polynomial of A.

4. (a) Define invariant subspace of a vector space. 1

(b) Let T be a linear operator on R^3 such that $T(a, b, c) = (a+b+c, a+b+c, a+b+c)$. Let $W = \{(t, t, t) \mid t \in R\}$ be a subspace of R^3.

Show that—

(i) W is a T-invariant subspace of R^3

(ii) the characteristic polynomial of T_W divides the characteristic polynomial of T. 6

Or

Let V be a finite-dimensional vector space over the field F and let T be a linear operator on V. Then show that T is diagonalizable if and only if the minimal polynomial for T has the form

$$p = (x - c_1) \cdots (x - c_k)$$

where $c_1, c_2, \cdots, c_k$ are distinct elements of F.

5. *(a)* If V is an inner product space, then for any vectors α, β in V and any scalar c, prove that $||\alpha + \beta|| \leq ||\alpha|| + ||\beta||$. 5

Or

Let V be an inner product space and let $\beta_1, \beta_2, \cdots, \beta_n$ be any independent vectors in V. Then construct orthogonal vectors $\alpha_1, \alpha_2, \cdots \alpha_n$ in V such that for each $k = 1, 2, \cdots, n$, the set $\{\alpha_1, \alpha_2, \cdots, \alpha_k\}$ is a basis for the subspace spanned by $\beta_1, \beta_2, \cdots, \beta_k$.

(b) Define orthogonal vectors. Consider the vectors $\beta_1 = (3, 0, 4)$, $\beta_2 = (-1, 0, 7)$, $\beta_3 = (2, 9, 11)$ in R^3 equipped with standard inner product. Apply the Gram-Schmidt orthogonalisation process to find orthogonal vectors corresponding to the given vectors. 1+4

(c) For any linear operator T on a finite dimensional inner product space V, prove that there exists a unique linear operator T^* on V such that $(T\alpha|\beta) = (\alpha|T^*\beta)$ for all $\alpha, \beta \in V$. 5

6. *(a)* Define adjoint of a linear operator T on a vector space V. Give an example of adjoint of a linear operator T on V. 2

(b) Answer any *two* questions from the following : 4×2=8

(i) Let V be a finite-dimensional inner product space. If T and U are linear operator on V, then prove that

(1) $(T+U)^* = T^* + U^*$

(2) $(T^*)^* = T$

(ii) Let $\{\alpha_1, \cdots, \alpha_n\}$ be an orthogonal set of non-zero vectors in an inner product space V. If β is any vector in V, then prove that

$$\sum_k \frac{|(\beta|\alpha_k)|^2}{\|\alpha_k\|^2} \leq \|\beta\|^2$$

(iii) Let V be a finite-dimensional inner product space, and f be a linear functional on V. Then show that there exists a unique vector β in V such that $f(\alpha) = (\alpha|\beta)$ for all α in V.

★★★