

2019

ZOOLOGY

(Major)

Paper : 3.2

(Cell Biology)

Full Marks : 60

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct answer (any seven) : $1 \times 7 = 7$
- (a) Microtubules consist primarily of the actin/myosin/tubulin protein.
 - (b) Active transport moves the substances across the plasma membrane against/along their concentration gradients using ATP/without ATP.
 - (c) During aerobic glycolysis 8/6/10 ATP molecules are produced.
 - (d) Oxidative phosphorylation takes place in ribosome/lysosome/cell membrane/ F_1 particle of mitochondria.
 - (e) Cell theory was put forwarded by Robert Hooke / Robert Brown / Leeuwenhoek/Schleiden and Schwann.

(2)

- (f) Naked DNAs are present in plant cell/
animal cell/bacterial cell/protozoa.
- (g) The center of a cell is cilia/flagella/
nucleus/centrioles.
- (h) G_0 phase lies at the end of
 $G_1/G_2/S$ -phase/M-phase.

2. Write short notes on the following (any four) :

2×4=8

- (a) Elementary particle
- (b) Ultrastructure of Golgi bodies
- (c) Molecular structure of nucleosome
- (d) Facilitated diffusion
- (e) Plasmid DNA or extra-chromosomal
DNA

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

- (a) Discuss the chemical properties of
protoplasm.
- (b) Differentiate between salivary and
lampbrush chromosomes.
- (c) Discuss the significance of mitotic and
meiotic cell divisions.
- (d) Differentiate between prokaryotic cell
and eukaryotic cell.
- (e) Why lysosomes are called 'suicide bag of
the cell'?

(3)

4. Describe the electron transport system of
mitochondria. 10

Or

Define endoplasmic reticulum. Write the
functions of ER. Explain the significance of
SER and RER. 1+6+3=10

5. Name the most popular two models of cell
membrane. Write a note on the functions of
plasma membrane with respect to transport
of solutes. 2+8=10

Or

What is mitotic apparatus? Describe their
structures, assembly and disassembly of the
microtubules and functions of mitotic
apparatus. 2+6+2=10

6. What is the natural recombination? When
does it take place? What is the outcome of
crossing-over? 2+4+4=10

Or

Why ribosomes are known as protein factory
of the cell? Describe how ribosomes are
involved in protein synthesis. 3+7=10

2019

ZOOLOGY

(Major)

Paper : 3.1

(Comparative Anatomy and Histology)

Full Marks : 60

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. State True or False (any two) : 1×2=2
- (a) Reticular fibres join connective tissues to other tissues.
 - (b) Chondrocranium is the cartilaginous envelope of the brain.
 - (c) In most of the vertebrates thyroid gland is originated from cartilage.
2. Fill in the blanks (any three) : 1×3=3
- (a) Toluidine blue is an example of _____ dye.
 - (b) Mammal's stomach is _____ in character.
 - (c) Branchiae are developed on the walls of some _____.
 - (d) The sense organ of scala media is known as _____.

(2)

3. Answer the following questions : $1 \times 2 = 2$

- (a) Which is the common connective tissue of vertebrates?
- (b) Write about functions and derivatives of somatic motor neuron.

4. Write notes on/Answer the following (any four) : $2 \times 4 = 8$

- (a) Different cells of connective tissue
- (b) Functions of blood
- (c) Mordant
- (d) Draw a neat labelled diagram of nephron.
- (e) Integument of fishes

5. Answer/Write notes on the following (any three) : $5 \times 3 = 15$

- (a) Describe the organ of hearing and balancing in amphibia.
- (b) Give a comparative account of thyroid gland in birds and mammals.
- (c) Describe the classification of dyes with their properties.
- (d) Mesonephros and metanephros kidney
- (e) Lymph and its functions

(3)

6. Answer the following questions (any three) :

$10 \times 3 = 30$

- (a) Explain about the different types of skeletal tissues, its occurrence, functions with proper diagrams.

$5 \times 2\frac{1}{2} + 2\frac{1}{2} = 10$

- (b) Describe the basic principles of fixation and staining. Write its importance in biological sciences.

$5 + 5 = 10$

- (c) Draw a labelled diagram of brain in Reptiles and describe its advancement over amphibian brain.

$5 + 5 = 10$

- (d) Give a comparative account of the integument in vertebrate series.

10

- (e) What is neuron? Write about the structure and function of a neuron.

$2 + 8 = 10$

3 (Sem-3) CHM

2019

CHEMISTRY

(General)

Full Marks : 40

Time : 2 hours

*The figures in the margin indicate full marks
for the questions*

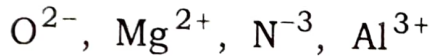
Answer either in English or in Assamese

1. Answer the following as directed : 1×5=5

তলত দিয়াবোৰৰ নিৰ্দেশ অনুসৰি উত্তৰ লিখা :

- (a) Arrange the following ions in the decreasing order of size :

তলত দিয়া আয়নসমূহক আকাৰ অনুযায়ী অধঃক্রমত সজোৱা :



- (b) What do you mean by limiting molar conductance?

সীমিত ম'লাৰ পৰিবাহিতা বুলিলে কি বুজা ?

(2)

- (c) Ammonia solution of alkali metal is blue in colour, why?
ক্ষাৰ ধাতুৰ এম'নিয়া দ্ৰৱৰ বৰণ কিয় নীলা হয়?
- (d) What is meant by catenation?
শৃংখলিতকৰণ মানে কি বুজা?
- (e) Banana bond in diborane is _____ bond.
(Fill in the blank)
ডাইব'ৰেনত বেনানা বান্ধোন হয় _____ বান্ধোন।
(খালী ঠাই পূৰণ কৰা)
2. (a) Give the structure of the following xenon compounds. Also indicate the type of hybridization of xenon in each of the compounds. Why has XeO_3 pyramidal structure? $3+2=5$
তলত দিয়া জেনন যৌগসমূহৰ গঠন ব্যাখ্যা কৰা। লগতে যৌগসমূহত থকা জেননৰ সংকৰণ অৱস্থা উল্লেখ কৰা। XeO_3 ৰ আকৃতি কিয় পিৰামিডীয় হয়?
 XeF_2 , XeF_6 , XeOF_4
Or / অথবা
- (b) What are carbides? Give one method to prepare graphite intercalation compound, silicon carbide and nickel carbide. $2+3=5$
কাৰ্বাইড কি? গ্ৰাফাইট সন্নিবিষ্ট যৌগ, ছিলিকন কাৰ্বাইড আৰু নিকেল কাৰ্বাইডৰ একোটাকৈ প্ৰস্তুত প্ৰণালী লিখা।

(3)

3. Answer any two of the following $5+2=7$
তলত দিয়াবোৰৰ দি কোনো দুটাৰ উত্তৰ লিখ।
- (a) (i) Explain with reasons $3+2=5$
কাৰণ সৰ্শি ব্যাখ্যা কৰা।
1. At room temperature H_2O is liquid but H_2S is gas.
সামান্য উষ্ণতাত H_2O তৰল কিন্তু H_2S গেছ।
2. Oxygen exists as O_2 while sulphur exists as S_8 .
অক্সিজেনৰ অস্তিত্ব হৈছে O_2 আনহাতে হালফাৰ অস্তিত্ব হৈছে S_8 .
- (ii) Write short notes on : $1+2=3$
সমু টোকা লিখ :
1. Borazine
ব'ৰাইজ
2. Silicones
ছিলিক'ন
- (b) (i) Discuss the structure and bonding of diborane. 5
ডাইব'ৰেনৰ গঠন আৰু বন্ধনৰ বিষয়ে আলোচনা কৰা।

(4)

(ii) Write down the names of the following complexes by IUPAC system : $\frac{1}{2} \times 4 = 2$

তলত দিয়া জটিল যৌগবোৰৰ নাম IUPAC পদ্ধতিত লিখা :

1. $[\text{CoN}_3(\text{NH}_3)_5]\text{SO}_4$
2. $\text{Ba}[\text{BrF}_4]_2$
3. $\text{Na}_3[\text{Ag}(\text{S}_2\text{O}_3)_2]$
4. $\text{Li}[\text{AlH}_4]$

(c) What is electronegativity? What are the factors which affect the electronegativity of an element? Discuss the trend of electronegativity among the elements in a period and in a group. $1+2+2=5$

বিদ্যুৎঋণতা কি? কি কি কাৰকে মৌল এটাৰ বিদ্যুৎঋণতাৰ ওপৰত প্ৰভাৱ পেলায়? একোটা পৰ্যায় আৰু একোটা বৰ্গত মৌলসমূহৰ বিদ্যুৎঋণতা কিদৰে সলনি হয়, আলোচনা কৰা।

4. Answer any two of the following : $5 \times 2 = 10$

তলত দিয়াবোৰৰ যি কোনো দুটাৰ উত্তৰ লিখা :

(a) Name two important ores of Ni. How is Ni extracted from its important ore? Give two properties of Ni. $1+3+1=5$

নিকেলৰ দুটা মুখ্য আকৰিকৰ নাম লিখা। মুখ্য আকৰিকৰ পৰা নিকেল কেনেকৈ নিষ্কাশন কৰা হয়? নিকেলৰ দুটা ধৰ্ম উল্লেখ কৰা।

(Continued)

(5)

Or / অথবা

(i) Discuss about Werner's theory of coordination compounds. 3

ৱাৰ্নাৰৰ সমন্বয় বৈশিষ্ট্য তত্ত্বটোৰ সংক্ষেপে আলোচনা কৰা।

(ii) Predict the molecular formula of the carbonyls of Ni with the help of EAN rule. 2

EAN নিয়মৰ সহায়ত নিকেলৰ কাৰ্বনিলৰ আণৱিক সংকেত নিৰূপণ কৰা।

(b) (i) Define essential element and trace element. Mention the biological roles of molybdenum and selenium. $1+2=3$

অত্যাৱশ্যকীয় মৌল আৰু অনুৰেখ মৌলৰ সংজ্ঞা দিয়া। ম'লিবডেনাম আৰু সেলেনিয়ামৰ জৈৱিক কাৰ্যত ভূমিকা কি উল্লেখ কৰা।

(ii) What is toxicity? Mention the toxicity that may happen due to Pb and Hg. $1+1=2$

বিষাক্ততা কি? Pb আৰু Hgৰ বাবে হ'ব পৰা বিষাক্ততা উল্লেখ কৰা।

(c) Define cis- and trans-isomers. Give the geometrical isomerism for the coordination entity $[\text{Cr}(\text{NH}_3)_2\text{Cl}_2(\text{en})]^+$. $2+3=5$

ছিছ-সমযোগী আৰু ট্ৰান্স-সমযোগীৰ সংজ্ঞা দিয়া। $[\text{Cr}(\text{NH}_3)_2\text{Cl}_2(\text{en})]^+$ এই সমন্বয়ী সত্তাৰ জ্যামিতীয় সমযোগীকেইটা দিয়া।

(6)

5. Answer any *two* of the following : $5 \times 2 = 10$
তলত দিয়াবোৰৰ যি কোনো দুটাৰ উত্তৰ লিখা :

- (a) (i) Discuss the determination of transport number of NO_3^- ion in AgNO_3 by Hittorf's method. 3
হিটর্ফৰ পদ্ধতিৰে AgNO_3 ত NO_3^- আয়নৰ বহনাংক নিৰ্ণয় পদ্ধতি আলোচনা কৰা।
- (ii) How would you account for the highest mobility of H^+ ions? 2
 H^+ আয়নৰ সৰ্বোচ্চ সঞ্চালনৰ কাৰণ কি ?

(b) Discuss conductometric titration for—

- (i) strong acid with a strong base;
(ii) weak acid with a strong base.

$$2\frac{1}{2} + 2\frac{1}{2} = 5$$

পৰিবাহিতামিতীয় অনুমাপন আলোচনা কৰা—

- (i) তীব্র অম্লক তীব্র ক্ষাৰকৰ দ্বাৰা;
(ii) মৃদু অম্লক তীব্র ক্ষাৰকৰ দ্বাৰা।

- (c) (i) λ_m° for NaOH , NaCl and BaCl_2 are $248.1 \times 10^{-4} \text{ Sm}^2 \text{ mol}^{-1}$, $126.5 \times 10^{-4} \text{ Sm}^2 \text{ mol}^{-1}$ and $280.0 \times 10^{-4} \text{ Sm}^2 \text{ mol}^{-1}$ respectively. Calculate λ_m° for Ba(OH)_2 . 2

(7)

NaOH , NaCl আৰু BaCl_2 ৰ λ_m° ৰ মান ক্ৰমে $248.1 \times 10^{-4} \text{ Sm}^2 \text{ mol}^{-1}$, $126.5 \times 10^{-4} \text{ Sm}^2 \text{ mol}^{-1}$ আৰু $280.0 \times 10^{-4} \text{ Sm}^2 \text{ mol}^{-1}$ হ'লে Ba(OH)_2 ৰ λ_m° ৰ মান গণনা কৰা।

- (ii) Discuss the construction and the use of a glass electrode. 3
কাচ ইলেক্ট্ৰ'ডৰ গঠন আৰু ব্যৱহাৰ সম্পৰ্কে আলোচনা কৰা।

3 (Sem-3) PHY M 2

2019

PHYSICS

(Major)

Paper : 3.2

(Current Electricity and Magnetostatics)

Full Marks : 60

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Answer the following : 1×7=7

- (a) State Ohm's law.
- (b) What do you mean by coefficient of self-inductance?
- (c) What do you mean by the time constant in series R-C circuit?
- (d) What is impedance?
- (e) What is transformation ratio?
- (f) Define Lorentz force.
- (g) What do you mean by magnetic induction?

(2)

2. Answer the following :

$2 \times 4 = 8$

- (a) What are peak value and mean value of alternating current?
- (b) What do you mean by thermocouple and thermo-e.m.f.?
- (c) What are magnetic flux and magnetic flux density?
- (d) Write the relation between true power and power factor.

3. Answer any *three* from the following :

$5 \times 3 = 15$

- (a) Calculate the value of the torque on a current loop placed in a uniform magnetic field.
- (b) An e.m.f. of 10 volts is applied to a circuit having a resistance of 10 ohms and an inductance of 0.5 henry. Find the time required by the current to attain 63.2 % of its final value. What is the time constant of the circuit?
- (c) A capacitor of capacitance 0.1 μF is first charged and then discharged through a resistance of 10 megaohms. Find the time, the potential will take to fall to half its original value.

20A/98

(Continued)

(3)

(d) The e.m.f. of a thermocouple, one junction of which is kept at 0°C , is given by $E = bt + ct^2$. Find the neutral temperature and the Peltier and Thomson coefficient.

(e) (i) What do you mean by mutual and self-inductance? 2

(ii) Two coils, a primary of 600 turns and a secondary of 30 turns are wound on an iron ring of radius 0.1 m and cross-section 4×10^{-2} m diameter. Find their mutual inductance (μ for iron = 800). 3

4. Answer any *three* from the following : $10 \times 3 = 30$

(a) Define the current density at any point. Derive an expression for current density. Prove the equation of continuity

$$\text{div } J + \frac{dy}{dt} = 0$$

(b) An alternating e.m.f. is applied to a circuit containing an inductor, capacitor and resistor in series. Obtain expression for the current, impedance and phase of current. Obtain the condition for the current to be a resonance with the applied e.m.f. Obtain the resonance frequency.

20A/98

(Turn Over)

- (c) A charge capacitor of capacitance C discharges through a circuit containing of a coil of inductance L and a resistance R . Find the charge on the capacitor in t sec after it starts discharging. Deduce the condition under which the discharge is oscillatory. Find the period and frequency of the oscillatory discharge, where R is very small.
- (d) State Biot-Savart law. Using Biot-Savart law, calculate the value of magnetic field due to an infinitely long straight wire carrying a current i amp at a distance d from the wire.
- (e) Write a short note on any *one* of the following :
- Transformer
 - Anderson's bridge

2019

CHEMISTRY
(Major)

Paper : 3.1

(Structure and Bonding)

Full Marks : 60

Time : 3 hours

The figures in the margin indicate full marks for the questions

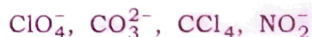
1. Answer the following questions : 1×7=7
- How is average value of a property associated with an operator of a normalized function expressed?
 - What is an eigenfunction?
 - Write the time independent Schrödinger equation for hydrogen atom.
 - What is the average distance of the electron of H atom from its nucleus?
 - Calculate the formal charge of P in PH_4^+ ion.

(2)

- (f) How does bond multiplicity affect bond length?
- (g) Why is a sigma bond stronger than a pi bond?

2. Answer the following questions : $2 \times 4 = 8$

- (a) Calculate the wavelength for transition of the electron of H atom in 2nd line of Balmer series. ($R_H = 1.1 \times 10^7 \text{ m}^{-1}$)
- (b) Calculate the effective nuclear charge for a 3d electron of cobalt atom.
- (c) Draw the Lewis electron dot structures of the following :



- (d) Give reason why BeF_2 is linear but SF_2 is V-shaped.

3. Answer any *three* of the following questions :

$5 \times 3 = 15$

- (a) What do you mean by bond moment and dipole moment? Give reason why NF_3 is less basic than NH_3 . $1 + 1 + 3 = 5$
- (b) Using VSEPR theory, explain the geometry of the following molecules :

$2 \frac{1}{2} \times 2 = 5$



20A/95

(Continued)

(3)

- (c) What do you understand by percent ionic character of covalent diatomic molecule? Calculate the percent ionic character of H—F bond. (Dipole moment for HF = 1.92 D, $e = 4.8 \times 10^{-10}$ e.s.u., H—F bond length = 0.92 Å) $2 + 3 = 5$
- (d) Calculate the de Broglie wavelength of an electron which is accelerated by applying a potential difference of 54 volts. ($h = 6.6 \times 10^{-34}$ J-s, $m = 9.1 \times 10^{-31}$ kg, $e = 1.6 \times 10^{-19}$ C) 5
- (e) Write a note on aufbau principle. 5

4. Answer the following questions : $10 \times 3 = 30$

- (a) Answer *either* (i) or (ii) and (iii) :

- (i) What is resonance? What are the essential rules for writing resonating structures? Draw the different resonating structures of CO_3^{2-} ion. $2 + 5 + 3 = 10$

Or .

- (ii) Explain Pauling and Mulliken scales of electronegativity. $3 + 3 = 6$
- (iii) Write the outlines of valence bond approach to bonding in diatomic molecules. 4

20A/95

(Turn Over)

(b) Answer either (i) or (ii) and (iii) :

(i) Show that for a black body radiator the energy density in the region between γ and $\gamma + d\gamma$ is given by

$$E_{\gamma} d\gamma = \frac{8\pi h\gamma^3}{C^3 (e^{h\gamma/kT} - 1)} d\gamma \quad 10$$

Or

(ii) How was the spinning property of an electron experimentally demonstrated by Stern-Gerlach? Explain. 6

(iii) From Pauli antisymmetry principle, prove that two electrons having same spin cannot exist in an orbital. 4

(c) Answer either (i) and (ii) or (iii) and (iv) :

(i) Find the wave function for p_x orbital. 6

(ii) Draw the radial probability distribution function for 2s, 3p, 4p and 5d orbitals. 4

Or

(iii) Prove that an s-orbital has no angular dependence. 4

(iv) Write a note on radial probability distribution function. 6

2019

CHEMISTRY
(Major)

Paper : 3.2

(Chemical Bonding)

Full Marks : 60

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Answer the following as directed : $1 \times 7 = 7$

(a) Which option best approximates the bond angle present in H_2Sn ?

(i) 102.5°

(ii) 180°

(iii) 104.5°

(iv) 120°

(Choose the correct option)

(2)

- (b) ClO_3^- and ClO_4^- ions have same number of electron pairs around central chlorine but their geometry is different. Why?
- (c) What happens when CsCl crystal is heated at high temperature?
- (d) What are Keesom forces?
- (e) If N is the number of tetrahedral voids in a close-packed structure, then the number of octahedral voids is _____.

(Fill in the blank)

- (f) Arrange O_2^+ , O_2 , O_2^- and O_2^{2-} in order of increasing bond order.
- (g) Highly charged cations are rare. Why?

20A/96

(Continued)

(3)

2. Answer the following questions : $2 \times 4 = 8$

- (a) Anhydrous AlCl_3 is covalent but $\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$ is ionic in nature. How would you account for this behavior?
- (b) When naphthalene is hydrated, the heat released is about 80 kcal/mol. Heat of hydrogenation of an isolated cyclohexene unit is equal to 28.8 kcal/mol. Estimate the resonance energy of naphthalene.
- (c) Discuss the Bent's rule by taking $(\text{CH}_3)_2\text{CCl}_2$ molecule as an example.
- (d) Why is alcohol a better drying agent than acetone?

3. Answer any *three* questions : $5 \times 3 = 15$

- (a) Draw the structure of CO_3^{2-} ion. If all the C—O bond distances are equal, then write the resonance structure to describe the bonding in CO_3^{2-} ion. Describe the bonding in CO_3^{2-} in terms of hybridization scheme.

$1+2+2=5$

20A/96

(Turn Over)

(b) Calculate the maximum radius of a sphere that may be accommodated in an octahedral hole in a closed-packed solid composed of spheres of radius r . 5

(c) Compare the following pairs of molecules with respect to the parameters cited within the parenthesis : 1×5=5

(i) CO^+ and CO (bond length)

(ii) SiCl_4 and CCl_4 (boiling point)

(iii) Na_2CO_3 and Cs_2CO_3 (solubility)

(iv) Cu^{2+} and Ca^{2+} (polarizing power)

(v) NH_2 and SF_4 (hybrid orbitals of the central atom)

(d) Discuss the electron probable density of bonding and antibonding molecular orbitals. 5

(e) Which of the following mixtures of solvents have intermolecular hydrogen bonding between the different solvent molecules?

(i) Et_2O and THF

(ii) EtOH and H_2O

(iii) EtNH_2 and Et_2O

Give diagrams to show likely hydrogen-bonded interactions. 2+3=5

4. Answer any three questions : 5×3=15

(a) What are MOs and how are they constructed? Discuss the MO energy level diagram of the triatomic molecule NO_2 and hence obtain its electronic configuration. 2+2+1=5

(b) How many Bravais lattice types are there and what are they? Name the orthorhombic Bravais lattices. Determine the density of CsCl which crystallizes in bcc type structure with edge length 412.1 pm. The atomic mass of Cs and Cl are 133 and 35.5 respectively. 2+1+2=5

(c) Discuss how steric and electronic factors affect the molecular properties. 5

(d) What are Miller indices? A certain crystal has lattice parameters of 4.24 \AA , 10 \AA and 3.66 \AA on X, Y, Z axes respectively. Determine the Miller indices of a plane having intercepts of 2.12 \AA , 10 \AA and 1.83 \AA on the X, Y and Z axes. $2+3=5$

(e) Predict the shapes, including the bond angles of the following : 5

(i) The ion PH_4^+

(ii) The molecule PF_5

(iii) The ion PF_6^-

(iv) The molecule XeF_4

5. Answer any *three* questions : $5 \times 3 = 15$

(a) When acetylene is passed through a solution of Cu(I) chloride, a red ppt of copper acetylide, CuC_2 is formed. This is a common test for the presence of acetylene. Describe the bonding in the C_2^{2-} ion in terms of molecular orbital theory and compare the bond order to that of C_2 . 5

(b) Derive the Born-Landé equation for lattice energy calculation. Give its importance and conclusions derived. $3+2=5$

(c) Justify the following : $2\frac{1}{2} \times 2 = 5$

(i) Sodium chloride and magnesium oxide both have identical structures. However, sodium chloride melts at 1074 K and magnesium oxide melts at 3125 K .

(ii) Cotton clothes dry slowly in comparison to synthetic clothes.

(d) What is the effect of temperature on the conductivity of semiconductors? Write a note on the applications of semiconductors. $2+3=5$

2019

MATHEMATICS

(Major)

Paper : 5.1

(Real and Complex Analysis)

Full Marks : 60

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

Symbols have usual meaning

1. Answer the following questions : 1×7=7

- (a) Write down a sufficient condition for the equality of f_{xy} and f_{yx} .
- (b) Give an example of a discontinuous function which is Riemann integrable.
- (c) If P^* is a refinement of a partition P of a bounded function f , then write down the relations between $U(P, f)$, $U(P^*, f)$, $L(P, f)$, $L(P^*, f)$.

(2)

(d) Define pole of order n of a complex valued function $f(z)$.

(e) A function $f(z) = u(x, y) + iv(x, y)$ is defined such that $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$. State whether f is analytic or not.

(f) Let $f(z) = u(x, y) + iv(x, y)$ be analytic in a region R . Prove that $\frac{\partial(u, v)}{\partial(x, y)} = |f'(z)|^2$.

(g) Find the fixed points of the transformation $w = z + 5$.

2. Answer the following questions : $2 \times 4 = 8$

(a) Show that

$$\lim_{x \rightarrow 0} \lim_{y \rightarrow 0} f(x, y) = \lim_{y \rightarrow 0} \lim_{x \rightarrow 0} f(x, y)$$

but $\lim_{(x, y) \rightarrow (0, 0)} f(x, y)$ does not exist, where

$$f(x, y) = \frac{xy}{x^2 + y^2}, \quad (x, y) \neq (0, 0) \\ = 0, \quad (x, y) = (0, 0)$$

20A/269

(Continued)

(3)

(b) Prove that the improper integral

$$\int_a^b \frac{dx}{(x-a)^n}$$

converges if and only if $n < 1$.

(c) Let C be the curve in the xy plane defined by $3x^2y - 2y^3 = 5x^4y^2 - 6x^2$. Find a unit vector normal to C at $(1, -1)$.

(d) Show that

$$\nabla = \frac{\partial}{\partial x} + i \frac{\partial}{\partial y} = 2 \frac{\partial}{\partial z}$$

3. Answer any three parts :

$5 \times 3 = 15$

(a) Show that the function

$$f(x, y) = \frac{x^2y}{x^4 + y^2}, \quad x^2 + y^2 \neq 0 \\ = 0, \quad x = y = 0$$

possesses first partial derivatives everywhere, including the origin, but the function is discontinuous at the origin.

(b) Prove that a bounded function f is integrable on $[a, b]$ iff for every $\epsilon > 0$, there exists a partition P of $[a, b]$ such that $U(P, f) - L(P, f) < \epsilon$.

20A/269

(Turn Over)

(c) Prove that every absolutely convergent improper integral is convergent.

(d) Given, $u = e^{-x}(x \sin y - y \cos y)$, find v such that $f(z) = u + iv$ is analytic.

(e) Evaluate $\int_C \bar{z} dz$ from $z=0$ to $z=4+2i$ along the curve C given by (i) $z = t^2 + it$ and (ii) the line from $z=0$ to $z=2i$ and then the line from $z=2i$ to $z=4+2i$.

4. Answer any one part :

10

(a) (i) Show that $f(x, y, z) = z - 2x = 0$, f is differentiable and $f_v \neq 0$, where $v = z - 2x$ satisfies the equation

$$x \frac{\partial z}{\partial x} - y \frac{\partial z}{\partial y} = 2x$$

5

(ii) Show that the function

$$f(x, y) = y^2 + x^2y + x^4$$

has a minimum at $(0, 0)$.

5

(b) (i) Show that $\int_0^1 x^m (1-x)^n dx$ exists if and only if m, n both are positive

(ii) Show that the integral

$$\int_0^1 \frac{\sin(x^p)}{x^p} dx, \quad p > 0$$

is absolutely convergent for $p > 1$

5. Answer any one part :

10

(a) (i) The roots of the equation in λ

$$(\lambda - x)^3 + (\lambda - y)^3 + (\lambda - z)^3 = 0$$

are u, v, w . Prove that

$$\frac{\partial(u, v, w)}{\partial(x, y, z)} = -2 \frac{(y-z)(z-x)(x-y)}{(u-v)(v-w)(w-u)}$$

5

(ii) Prove that if f and g are Riemann integrable on $[a, b]$, then $f + g, f - g$ are also Riemann integrable on $[a, b]$.

5

(b) (i) Show that the function $[x]$, where $[x]$ denotes the greatest integer not greater than x , is Riemann integrable in $[0, 3]$.

5

- (ii) Prove that if a function f is bounded and integrable on $[a, b]$ and there exists a function F such that $F' = f$ on $[a, b]$, then $\int_a^b f \, dx = F(b) - F(a)$.

5

6. Answer any one part :

10

- (a) (i) Prove that if

$$w = f(z) = u(x, y) + iv(x, y)$$

is analytic, then

$$\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y} \text{ and } \frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x}$$

5

- (ii) Let $u(x, y) = \alpha$ and $v(x, y) = \beta$, where u and v are the real and imaginary parts of an analytic function $f(z)$ and α, β are the constants, represent two families of curves. Prove that if $f'(z) \neq 0$, then the families are orthogonal.

5

- (b) (i) Let $f(z)$ be analytic inside and on a circle C of radius r and centre at $z = a$. Then prove that

$$f^{(n)}(a) \leq \frac{Mn!}{r^n}, \quad n = 0, 1, 2, \dots$$

where M is a constant such that $|f(z)| < M$ on C and $f^{(n)}(a)$ represents n -th derivative of $f(z)$ at $z = a$.

5

- (ii) Let the rectangular region R in the z -plane be bounded by $x=0, y=0, x=2, y=1$. Determine the region R' of the w -plane into which R is mapped under the transformation

1. $w = z + (1 - 2i)$

2. $w = \sqrt{2}e^{i\pi/4}z$

2+3=5

3 (Sem-5) BOT M 1

2 0 1 9

BOTANY

(Major)

Paper : 5.1

(Microbiology and Immunology)

Full Marks : 60

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

1. Give very short answers :

1×7=7

(a) What is biofilm?

(b) Define the term bioaerosol.

(c) What is apoptosis?

(d) Name the causal organism of Rocky Mountain spotted fever.

(e) Define a strain.

(f) What is a fore spore?

(g) What are transposons?

(Turn Over)

2. Write the difference between $2 \times 4 = 8$

- (a) Catabolic and Anabolic pathway
- (b) Active and Passive immunity
- (c) Virus and Virusoids
- (d) Fungi and Actinomycetes

3. Write on any *three* of the following : $5 \times 3 = 15$

- (a) Application of microbes in sewage treatment
- (b) A typical bacterial growth curve and its different phases
- (c) Tobacco Mosaic Virus
- (d) Allergic disorders caused by air microflora
- (e) Biological nitrogen fixation

4. Answer the following questions :

- (a) How do biogeochemical cycles maintain soil fertility? Give a detailed account of cycling of elemental sulphur in nature and the role played by microbes $2 \times 8 = 10$

Or

Write about the characteristic features of Mycoplasmas and the diseases caused by them. Why are they resistant to antibiotics?

$7 \times 2 + 1 = 10$

(Continued)

- (b) What are the nutrients required by bacteria? Write the characteristics of major nutritional categories of bacteria based on carbon, energy and electron sources $1 \times 4 = 4$

Or

What is transduction? Elaborate the process of transduction with suitable diagram. Differentiate between generalized and specialized transduction $1 \times 7 + 2 = 9$

- (c) What is immunoglobulin? Write about the structure of immunoglobulin and their different classes $1 \times 5 + 3 = 8$

Or

Name the T cells involved in cellular immunity. Describe briefly their roles for combatting pathogens. How does cellular immunity differ from humoral immunity? $1 \times 7 + 2 = 9$
