

Total No. of Printed Pages—3

3 SEM TDC BOTH (CBCS) C 7

2021

(Held in January/February, 2022)

BOTANY

(Core)

Paper : C-7

(**Genetics**)

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 of the following :

1×5=5

- (a) Chromosomal theory of inheritance was proposed by T. H. Morgan / Hugo de Vries / Correns / Sutton and Boveri.
- (b) Gene for colour blindness in man is located on both X and Y chromosomes / Y chromosome / X chromosome / None of these.

(2)

- (c) Genetic drift is the mechanism of evolution / recombination / replication / translation.
- (d) When two genes have the same expression of the character, then the phenomenon is known as Pleiotropy / Penetrance / Expressivity / Epistasis.
- (e) Linkage decreases as the distance between two genes decreases / increases / unaffected / None of these.
2. Write short notes on any *three* of the following : $4 \times 3 = 12$
- (a) Codominance
- (b) Inversion
- (c) Mutagens
- (d) Cytological basis of crossing-over
- (e) Translocation ring
3. What do you mean by epistasis? How does it differ from dominance? Describe it with suitable example. $2+2+8=12$

Or

Write short notes on the following : $6+6=12$

- (a) Chromosome theory of inheritance
- (b) Role of transposons in mutation

(3)

4. Write the difference between the following : $3 \times 4 = 12$
- (a) Euchromatin and Heterochromatin
- (b) Sex-limited and Sex-influenced traits
- (c) Penetrance and Expressivity
- (d) Multiple alleles

Or

What is linkage? Differentiate between complete and incomplete linkage. Describe briefly the significance of linkage. $2+8+2=12$

5. What do you mean by speciation? Describe the different types of speciation. What is the significance of speciation? $2+8+2=12$

Or

What is cytoplasmic inheritance? How is cytoplasmic inheritance different from chromosomal inheritance? Give an account of cytoplasmic inheritance with special reference to plastid inheritance. $1+3+8=12$

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3 SEM TDC BOTH (CBCS) C 6

2021

(Held in January/February, 2022)

BOTANY

(Core)

Paper : C-6

(**Economic Botany**)

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) _____ is the centre of origin of wheat.

(b) NBPGR stands for _____.

(c) The scientific name of cotton is _____.

(d) _____ is the source of chewing gum.

(e) Ethnobotany deals with the direct
relation of plants with _____.

(2)

2. Write short notes on any four of the following : $3 \times 4 = 12$

(a) Wood seasoning

(b) Essential oils

(c) Cinchona

(d) Biodiesel

(e) Turmeric

3. Write the scientific names along with their families of the following plants and give short accounts on their economic importance of their useful parts (any three) : $(1+1+2) \times 3 = 12$

(a) Rubber

(b) Castor

(c) Ashwagandha

(d) Tobacco

(e) Teak

4. Write an account on cultivation along with processing and economic utilization of coffee. $5+5+2=12$

(3)

5. Name any two fibre yielding plants, giving their families. Describe the methods of fibre extraction from them and their commercial uses. $(1+1+4) \times 2 = 12$

Or

What do you mean by domestication of plants? Write an explanatory note on Vavilov's centre of origin of crop plants.

$4+8=12$

Total No. of Printed Pages—3

3 SEM TDC BOTH (CBCS) C 5

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(Held in January/February, 2022)

BOTANY

(Core)

Paper : C-5

(**Anatomy of Angiosperms**)

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 of the following : 1×3=3

(a) Lateral roots are _____ in origin.

(b) The hard corky layer of coconut is an example of _____ tissue.

(c) The tunica-carpus theory was put forwarded by _____.

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(Turn Over)

(2)

2. Choose the correct answer from the following : $1 \times 2 = 2$

- (a) The inactive and passive cell in root apex is known as tunica-carpus/quiescent centre/calyptragen.
- (b) Primary/Secondary/Lateral/Intercalary meristem helps in increasing girth of plants.

3. Explain any four of the following : $3 \times 4 = 12$

- (a) Importance of plant anatomy in systematics
- (b) Ergastic substances
- (c) Plasmodesmata and pits
- (d) Hydathodes
- (e) Quiescent centre
- (f) Casparian strip

4. Differentiate between any three of the following : $4 \times 3 = 12$

- (a) Root apex and Shoot apex
- (b) Lithocysts and Laticifers
- (c) Heartwood and Sapwood
- (d) Monocot and Dicot stem anatomy
- (e) Meristematic tissue and Permanent tissue

(3)

5. What is conducting tissue? Discuss the components and their functions of conducting tissues. $2+10=12$

Or

What are the characteristic features of xerophyte? Describe different types of anatomical adaptation of xerophytes giving their salient features. $4+8=12$

6. What is cambium? Discuss the role of cambium in secondary growth in plants. $2+10=12$

Or

Write explanatory notes on the following : $6 \times 2 = 12$

- (a) Kranz anatomy
- (b) Types and function of stomata in dicot plant

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3 SEM TDC ZOOH (CBCS) C 5

2 0 2 1

(Held in January/February, 2022)

ZOOLOGY

(Core)

Paper : C-5

(Diversity of Chordata)

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) Balanoglossus belongs to the subphylum _____.
- (b) Migration of fish from freshwater to sea water is called _____.
- (c) _____ is the connecting link between reptiles and birds.
- (d) _____ is an example of Cyclostomata.
- (e) _____ concept is associated with Echinoderm theory.

(2)

2. Write short notes on any *three* of the following : $4 \times 3 = 12$

(a) Flight adaptations in birds

(b) Migration in fishes

(c) Affinities of Sphenodon

(d) Parental care in amphibians

3. Describe the general characteristics of Cephalochordata. 6

Or

Give an outline classification of chordates. 6

4. What is parental care? Elaborate the different patterns of parental care in fishes. $2+8=10$

Or

Describe the general characteristics and classification up to orders of the phylum Amphibia. $5+5=10$

5. Describe about the biting mechanism of poisonous snakes. 10

(3)

Or

Write ten general characteristics of the phylum Aves. Mention the characters of the order Casuariiformes and Dinornithiformes.

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

6. What is adaptive radiation? Elaborate the mechanism with reference to locomotory appendages in mammals. $2+8=10$

Or

Define 'zoogeographical realms'. Explain about the distribution of vertebrates in different realms. $2+8=10$

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3 SEM TDC ZOOH (CBCS) C 7

2021

(Held in January/February, 2022)

ZOOLOGY

(Core)

Paper : C-7

(**Fundamentals of Biochemistry**)

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) The linkage between two monosaccharides is called _____.
- (b) The number of stereoisomer(s) of sugar having one chiral carbon is _____.
- (c) The non-protein part of enzyme is _____.
- (d) Nucleic acids are polymers of _____.
- (e) Immunoglobulin _____ can pass through human placenta.

(2)

2. (a) Distinguish between (any two) : $3 \times 2 = 6$

(i) Saturated and Unsaturated fatty acids

(ii) Phospholipid and Glycolipid

(iii) Allosteric enzymes and Isozymes

(b) Draw the structures and write the significance of the following (any two) :

$3 \times 2 = 6$

(i) Disulphide linkage

(ii) Phosphodiester linkage

(iii) Peptide bond

(iv) Cot curve

3. Define V_{max} and K_m of an enzyme catalyzed reaction. Describe the mechanism of action of an enzyme catalyzed reaction. $2+7=9$

Or

Write an explanatory note on different types of enzyme inhibition. Describe the factor affecting enzyme activity. $6+3=9$

4. Write a comparative account on the structures of A, B and Z forms of DNA. 9

Or

Draw labelled diagrams of (a) tRNA and (b) nitrogenous bases of RNA. $4\frac{1}{2} \times 2 = 9$

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(Continued)

(3)

5. Define carbohydrate. Give an outline classification of different types of carbohydrate. Add a note on biological significance of carbohydrates. $1+5+3=9$

Or

What are immunoglobulins? Write about the different classes of immunoglobulins with their functions. $1+4+4=9$

6. What are fatty acids? Explain the physiological importance of lipids. $2+7=9$

Or

What are phospholipids and glycolipids? Add a note on the importance of steroids. $4+5=9$

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3 SEM TDC ZOOH (CBCS) C 7

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3 SEM TDC ZOOH (CBCS) C 6

2021

(Held in January/February, 2022)

ZOOLOGY

(Core)

Paper : C-6

**(Animal Physiology : Controlling and
Coordinating System)**

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) Blood is a type of ____ tissue.
 - (b) Human chorionic gonadotropic hormone is secreted by ____.
 - (c) Muscle filaments are known as ____.
 - (d) The sperms of seminiferous tubules are nourished by ____ cells.
 - (e) ____ gland is also known as third eye.

(2)

2. Distinguish between the following (any two) :

3×2=6

- (a) Simple squamous and brush-bordered ciliated cuboidal epithelium
- (b) Cartilage and bone
- (c) Isotonic and isometric muscle contractions

3. Write illustrative notes on the following (any two) :

3×2=6

- (a) Histology of pituitary gland
- (b) Neurotransmitter
- (c) Placental hormone
- (d) Function of somatotrophic hormone

4. Write short notes on the following (any two) :

4½×2=9

- (a) Ultrastructure of seminiferous tubule
- (b) Oogenesis
- (c) Menstrual cycle
- (d) Thyroxine hormone

5. What is neuron? Describe the propagation of action potential along the myelinated and non-myelinated nerve fibres.

1+8=9

(3)

Or

What is reflex action? Discuss about its types.

1+8=9

6. Describe the ultrastructure of skeletal muscle with illustrative diagram.

6+3=9

Or

Explain the chemical basis of muscle contraction.

9

7. What do you mean by signal transduction? Describe the mechanism of action of steroidal and non-steroidal hormones.

2+7=9

Or

Describe the structure and functions of neuromuscular junction. Compare between cardiac and smooth muscle fibres.

6+3=9

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3 SEM TDC CHMH (CBCS) C 5

2021

(Held in January/February, 2022)

CHEMISTRY

(Core)

Paper : C-5

(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 : 1×6=6

(a) The metal oxide which cannot be reduced by carbon is

(i) ZnO

(ii) PbO

(iii) Fe₂O₃

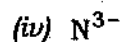
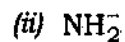
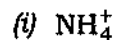
(iv) Cr₂O₃

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(Turn Over)

(2)

(b) The conjugate base of NH_3 is



(c) Number of 3c—2e bonds present in diborane is

(i) 3

(ii) 1

(iii) 4

(iv) 2

(d) The type of hybridization in NO_2^- ion is

(i) sp

(ii) sp^2

(iii) sp^3

(iv) dsp^3

(3)

(e) The shape of XeF_4 molecule is

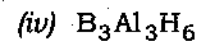
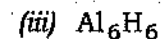
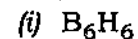
(i) tetrahedral

(ii) square planar

(iii) T-shape

(iv) octahedral

(f) The formula of inorganic benzene is



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

2×2=4

(a) Carbon reduction process

(b) Van-Arkel process

(c) Hydrometallurgy

(4)

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

3×2=6

- (a) What are hard and soft acids and bases (HSAB)? Mention one application of HSAB principle. 2+1=3
- (b) What are Lewis acids? Classify different types of Lewis acids with example. 1+2=3
- (c) What are conjugate acid-base pair? Applying this concept, explain why water can act both as acid and base. 1+2=3

4. Answer any *five* of the following questions :

2×5=10

- (a) What is inert-pair effect?
- (b) Explain the term 'diagonal relationship' with a suitable example.

(5)

(c) Among halides, lithium iodide is the most covalent in nature. Why?

(d) Write the name and formula of two peroxyacids of sulphur.

(e) What are pseudohalogens? Give example.

(f) What are silanes? Give examples.

5. Answer any *five* of the following questions :

3×5=15

- (a) Write one method of preparation and one use of boric acid. 2+1=3
- (b) Explain the bonding and structure of B_2H_6 . 2+1=3
- (c) Draw the electronic structure of HNO_3 , N_2O_4 and HNO_2 . 1+1+1=3
- (d) What are interhalogen compounds? Predict the geometry of ClF_3 and IF_7 . 1+1+1=3

(6)

- (e) What are carboranes? Give one example and structure of carborane. 1+1+1=3
- (f) Name the allotropes of phosphorous and draw their structures. 1+1+1=3

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

- (a) Give one method of preparation and one chemical property of XeF_6 .
- (b) Applying VSEPR theory, explain the geometry of XeF_2 .
- (c) What are clathrates? Give one example of clathrates of noble gases.

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

- (a) What are phosphazenes? Give a method of preparation of trimeric phosphonitrilic chloride. What happens when triphosphazene chloride is hydrolysed?
1+1+1=3

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(Continued)

(7)

- (b) Give one method of preparation and bonding structure of borazine. 1+2=3
- (c) Give one method of preparation of linear, crosslinked and cyclic silicones.
1+1+1=3

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3 SEM TDC CHMH (CBCS) C 5

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3 SEM TDC CHMH (CBCS) C 6

2 0 2 1

(Held in January/February, 2022)

CHEMISTRY

(Core)

Paper : C-6

(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 : 1×5=5

(a) S_N1 reaction undergoes in

(i) polar aprotic solvent

(ii) polar protic solvent

(iii) non-polar solvent

(iv) None of the above

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(Turn Over)

(2)

(b) Aldol condensation between which of the following followed by dehydration gives mesityl oxide?

- (i) Two moles of acetaldehyde
- (ii) Two moles of acetone
- (iii) CH_3CHO and HCHO
- (iv) CH_3CHO and CH_3COCH_3

(c) An unknown compound gives a positive haloform test and positive Fehling's test. The compound is

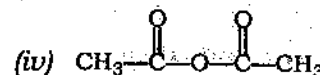
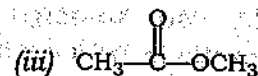
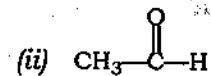
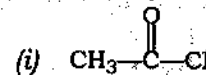
- (i) formaldehyde
- (ii) acetone
- (iii) benzaldehyde
- (iv) acetaldehyde

(d) Which of the following phenols is most acidic?

- (i) *o*-Nitrophenol
- (ii) *p*-Nitrophenol
- (iii) 2,4-Dinitrophenol
- (iv) 2,4,6-Trinitrophenol

(3)

(e) Among the given compounds, the most susceptible to nucleophilic attack at the carbonyl group is

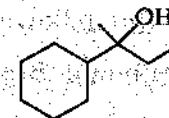


UNIT-I

2. Answer any five of the following questions :

2×5=10

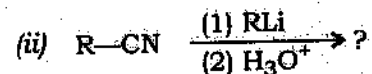
- (a) Giving a suitable example, show that in an $\text{S}_{\text{N}}2$ reaction inversion takes place.
- (b) How would you synthesize the following alcohol from appropriate alkene?



- (c) Discuss the benzyne mechanism for nucleophilic aromatic substitution reaction. Give evidences in support of the proposed mechanism.

(4)

(d) Complete the following organometallic reactions :



(e) Benzyl chloride can undergo both $\text{S}_{\text{N}}1$ and $\text{S}_{\text{N}}2$ reactions with high rate. Explain.

(f) Synthesize the following :

(i) Ethyl bromide by Hunsdiecker reaction

(ii) Fluorobenzene through diazonium salt

UNIT—II

3. Answer any three of the following questions :

2×3=6

(a) Synthesize the following :

1+1=2

(i) *m*-Nitrophenol from benzene

(ii) *m*-Cresol from *p*-toluidine

(b) Dehydration of alcohols to form alkenes is always carried out with conc. H_2SO_4 and not with conc. HCl or HNO_3 . Explain why.

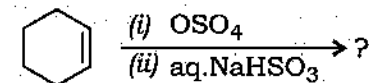
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(5)

(c) Prepare glycerol from propene.

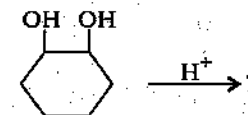
(d) Complete the following reaction :



4. Answer any two of the following questions :

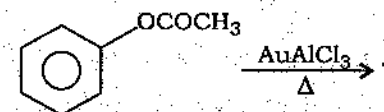
3×2=6

(a) Complete the following reaction and discuss the mechanism :



(b) Prepare 1°, 2° and 3° alcohols by using Grignard reagent and give the reactions.

(c) Complete the following rearrangement and suggest the mechanism :



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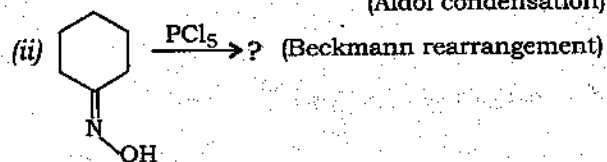
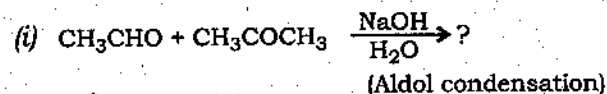
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(6)

UNIT—III

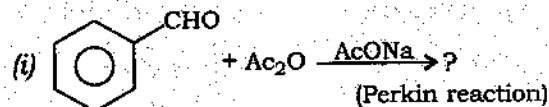
Answer either Q. No. 5 or Q. No. 6

5. (a) Complete the following reactions and write down the mechanisms : $3 \times 2 = 6$



- (b) Trichloroacetaldehyde is more reactive towards the nucleophilic addition reaction than acetaldehyde. Explain. 2

6. (a) Complete the following reactions and write down the possible mechanisms : $3 \times 2 = 6$



- (b) Synthesize the following : $1+1=2$
- (i) Cinnamaldehyde by using Claisen-Schmidt condensation
- (ii) Acrolein from glycerol

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(Continued)

(7)

7. Answer any two of the following questions :

$2 \times 2 = 4$

- (a) Mention synthetic applications of the following reagents (any two) : $1 \times 2 = 2$

(i) PCC (Pyridinium chlorochromate)

(ii) HIO_4 (Periodic acid)

(iii) SeO_2 (Selenium dioxide)

- (b) What is Clemmensen reduction? Explain with a suitable reaction. $1+1=2$

- (c) What is active methylene compound? Show the keto-enol tautomerism in ethylacetoacetate. $1+1=2$

8. Mention a synthetic application of diethylmalonate. 1

Or

Synthesize methyl vinyl ketone from acetone.

UNIT—IV

Answer either Q. No. 9 or Q. No. 10

9. (a) How will you convert a carboxylic acid into an ester without using an alcohol? 2
- (b) Convert acetone to 3-methyl butanoic acid using Reformatsky reaction. 2

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(Turn Over)

(8)

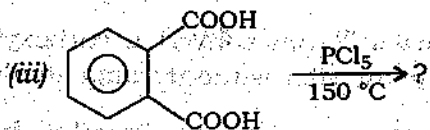
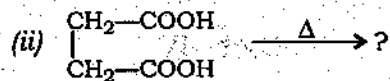
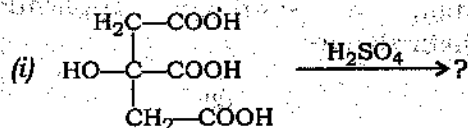
- (c) Complete the following reaction and suggest the mechanism : 3



- (d) Synthesize lactic acid from propene. 2

10. (a) The C—O bond length in RCOOH is shorter than in R—OH. Explain. 2

- (b) Complete the following reactions (any two) : 1×2=2



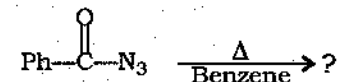
22P/208

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(9)

- (c) Convert butanoic acid to propanoic acid using Curtius rearrangement. 3

- (d) Complete the following reaction and write down the mechanism : 2



UNIT—V

Answer any two questions

11. Give one method of preparation of thioether. What happens when a thiol reacts with an aldehyde in the presence of hydrochloric acid? 2
12. What are mercaptans? How will you prepare ethyl mercaptan from ethyl halide? 2
13. What are thioethers? How do you obtain diethyl thioether from ethyl mercaptan? What happens when a thioether is oxidized with H_2O_2 ? $\frac{1}{2} + \frac{1}{2} + 1 = 2$

22P—2300/208

3 SEM TDC CHMH (CBCS) C 6

3 SEM TDC CHMH (CBCS) C 7

2021

(Held in January/February, 2022)

CHEMISTRY

(Core)

Paper : C-7

(**Physical 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 : 1×5=5

(a) When benzoic acid distributes between benzene and water, it dimerizes in benzene layer. The exact expression for Nernst's distribution law is

(i) $\sqrt{\frac{C_{org}}{C_{aq}}}$

(ii) $\frac{C_{org}^2}{C_{aq}}$

(iii) $\frac{\sqrt{C_{org}}}{C_{aq}}$

(iv) $\frac{C_{org}}{\sqrt{C_{aq}}}$

(2)

(b) For a chemical reaction

$$T_{1/2} \propto \frac{1}{a^2}$$

where a is the initial concentration of the reactant. The order of the reaction is

(i) 3

(ii) 2

(iii) 1

(iv) 0

(c) Which of the following is not a characteristic of enzyme catalysis?

(i) Enzyme catalysts are highly efficient

(ii) One enzyme can catalyse more than one reaction

(iii) The effectiveness of catalyst is maximum at its optimum temperature

(iv) Enzyme catalysis is dependent upon the pH of the solution

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(Continued)

(3)

(d) Sulphur can exist as sulphur rhombic(s), sulphur monoclinic(s), liquid sulphur(l) and sulphur vapour(g). Maximum number of phases which can coexist in equilibrium can be

(i) 3

(ii) 4

(iii) 1

(iv) 2

(e) The absorbent used for humidity and moisture control in many utility items is

(i) activated charcoal

(ii) silica gel

(iii) metal nanoparticles

(iv) finely divided nickel

2. Answer the following questions : $2 \times 5 = 10$

(a) Water and sulphur both are one-component system. Water system has one triple point but, sulphur system has more than one triple point in the phase diagram. Explain.

2

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(Turn Over)

(4)

- (b) What is critical solution temperature (CST)? Give one example each of solution with lower and upper CST. 1+1=2
- (c) Describe the Ostwald isolation method for determination of order of a reaction. 2
- (d) Explain the effect of particle size in heterogeneous catalysis. 2
- (e) When the adsorbate is adsorbed onto a surface of adsorbent, then both the enthalpy and entropy changes become negative. Explain. 2

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

6×2=12

- (a) (i) Derive Gibbs phase rule thermodynamically for reactive and non-reactive systems. 4
- (ii) What are condensed systems? Write phase rule equation for such systems. 1+1=2
- (b) (i) Melting point of pure Pb is 327 °C and of pure Ag is 961 °C and eutectic point is observed at 303 °C with 97.4% of Pb and 2.6% of Ag. Draw a labelled phase diagram of Pb-Ag system. 2

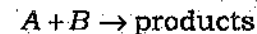
(5)

- (ii) What do you mean by peritectic change? Discuss the phase diagram of Na₂SO₄-H₂O system. 1+3=4
- (c) (i) Derive Duhem-Margules equation for a binary solution. 3
- (ii) State Nernst distribution law. State the principle of solvent extraction on the basis of Nernst distribution law. 1+2=3

4. Answer any *two* of the following questions :

6×2=12

- (a) (i) Derive an expression of rate constant for the following second-order reaction :



Prove that when either A or B is taken in excess, then this second-order reaction shows first-order kinetics. 3+1=4

- (ii) The values of rate constants for a chemical reaction at 427 °C and 527 °C are 2.0 s⁻¹ and 20 s⁻¹ respectively. Evaluate energy of activation for the reaction. 2
- (b) (i) Give one example of reversible reaction. Discuss the kinetics of first-order reversible reaction



(6)

(ii) Write different steps involved in the mechanism of chain reactions. 2

(c) (i) Discuss Lindemann's mechanism of a unimolecular gas phase reaction. Show that according to this mechanism a gaseous unimolecular reaction becomes first order at high pressure and second order at low pressure. 4

(ii) Discuss the drawbacks of collision theory of reaction rate. 2

5. Answer any *two* of the following questions :

$4\frac{1}{2} \times 2 = 9$

(a) Derive Michaelis-Menten equation for enzyme catalysis. $4\frac{1}{2}$

(b) Discuss different steps of adsorption theory for heterogeneous catalysis. $4\frac{1}{2}$

(c) What is acid-base catalysis? Discuss different mechanisms of acid-base catalysis. $1 + 3\frac{1}{2} = 4\frac{1}{2}$

6. Answer any *one* of the following questions : 5

(a) Derive Langmuir adsorption equation. Show that under low pressure condition the Langmuir adsorption equation becomes equal to Freundlich adsorption equation. $4 + 1 = 5$

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(Continued)

(7)

(b) (i) Show five main categories of adsorption isotherms diagrammatically. $2\frac{1}{2}$

(ii) Write basic differences between chemisorption and physisorption. Why is heat of adsorption greater for chemisorption than physisorption? $1\frac{1}{2} + 1 = 2\frac{1}{2}$

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3 SEM TDC PHYH (CBCS) C 5

2 0 2 1

(Held in January/February, 2022)

PHYSICS

(Core)

Paper : C-5

(**Mathematical Physics—II**)

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 : 1×5=5

(a) The value of $\operatorname{erf}_c(x) + \operatorname{erf}_c(-x)$ is

(i) 1

(ii) 2

(iii) -1

(iv) 0

(2)

(b) The value of $\Gamma\left(-\frac{1}{2}\right)$ is

(i) $\sqrt{\pi}$

(ii) $-\frac{\pi}{2}$

(iii) $-2\sqrt{\pi}$

(iv) 0

(c) The value of Legendre polynomial $P_2(x)$ is

(i) $(1-3x^2)$

(ii) $\frac{1}{2}(3x^2-1)$

(iii) $(3x^2-1)$

(iv) $\frac{1}{2}(1-3x^2)$

(d) The differential equation

$$\frac{d^2y}{dx^2} - 2x \frac{dy}{dx} + 2ny = 0$$

is known as

(i) Legendre's equation

(ii) Bessel's equation

(iii) Laguerre's equation

(iv) Hermite's equation

(3)

(e) The sum $1 + \frac{1}{2^2} + \frac{1}{3^2} + \frac{1}{4^2} + \dots$ is

(i) $\frac{\pi^2}{12}$

(ii) $\frac{\pi^2}{6}$

(iii) $\frac{\pi^2}{8}$

(iv) None of the above

2. (a) State the Dirichlet's conditions for a Fourier series. 2

(b) Expand the function $f(x) = x \sin x$ in a Fourier series in the interval $-\pi \leq x \leq \pi$. Hence show that

$$\frac{1}{1 \cdot 3} - \frac{1}{3 \cdot 5} + \frac{1}{5 \cdot 7} - \dots = \frac{\pi - 2}{4} \quad 4+2=6$$

(c) Expand $f(x) = e^x$ in a cosine series over $(0, 1)$. 3

3. (a) What do you mean by ordinary and singular points of a differential equation? Find the nature of the point $x = -1$ with reference to the differential equation

$$x^2(x+1) \frac{d^2y}{dx^2} + (x^2-1) \frac{dy}{dx} + 2y = 0 \quad 1+2=3$$

(4)

(b) Solve the following using Frobenius method (any one) : 5

(i) $9x(1-x)y'' - 12y' + 4y = 0$

(ii) $xy'' + y + xy = 0$

(c) Express $2-3x+4x^2$ in terms of Legendre polynomials. 3

Or

Prove that

$$\int_{-1}^1 x P_n(x) P_{n-1}(x) dx = \frac{2n}{4n^2 - 1}$$

(d) Evaluate the following : 2+2=4

(i) $P_n(1)$

(ii) $\int_{-1}^1 P_3^2(x) dx$

4. Evaluate : 3

$$\int_0^{\infty} x^{n-1} e^{-h^2 x^2} dx$$

Or

Show that

$$\Gamma(n)\Gamma(1-n) = \frac{\pi}{\sin n\pi}$$

(5)

5. Answer any two of the following : 3×2=6

(a) Find the absolute error, relative error and percentile error when 754126 is rounded to four significant digits.

(b) If $u = \frac{5x^3 y^4}{z^5}$ and errors in x, y, z be 0.001, compute the relative maximum error when $x = y = z = 1$.

(c) State and prove the normal law of errors.

6. (a) Solve any two of the following partial differential equations by method of separation of variables : 4×2=8

(i) $\frac{\partial^2 z}{\partial x^2} - 2\frac{\partial z}{\partial x} + \frac{\partial z}{\partial y} = 0$

(ii) $\frac{\partial^2 u}{\partial x \partial t} = e^{-t} \cos x$, under the conditions

$$u = 0 \text{ at } t = 0; \frac{\partial u}{\partial t} = 0 \text{ at } x = 0$$

(iii) $\frac{\partial^2 u}{\partial x^2} = \frac{\partial u}{\partial y} + 2u$, under the conditions

$$\text{at } x = 0, u = 0 \text{ and } \frac{\partial u}{\partial x} = 1 + e^{-3y}$$

(b) Find the solution of one-dimensional wave equation in Cartesian coordinates. 5

Or

Find the solution of 2-D Laplace's equation in cylindrical coordinates.

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2021

(Held in January/February, 2022)

PHYSICS

(Core)

Paper : C-6

(Thermal 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 : 1×5=5

(a) The zeroth law of thermodynamics introduces the concept of

- (i) heat (ii) temperature
(iii) entropy (iv) internal energy

(b) Which of the following is a correct expression for the first law of thermodynamics?

- (i) $dQ = dU + PdV$ (ii) $dU = dQ + PdV$
(iii) $dQ = dU - PdV$ (iv) None of the above

- (c) Which of the following is the largest unit of heat?
 (i) Electron volt (ii) Joule
 (iii) Calorie (iv) Erg
- (d) Which of the following thermodynamic laws gives the concept of enthalpy?
 (i) First law of thermodynamics
 (ii) Zeroth law of thermodynamics
 (iii) Second law of thermodynamics
 (iv) Third law of thermodynamics
- (e) Mean free path of a gas
 (i) increases with increase in pressure
 (ii) decreases with increase in pressure
 (iii) is independent of pressure
 (iv) has no linear relation with pressure
2. (a) State and explain the zeroth law of thermodynamics. 2
- (b) Applying the first law of thermodynamics, obtain a relationship between the specific heats of an ideal gas. 4
- (c) A Carnot's engine running between 1000 K and 500 K has the same efficiency as that running between x K and 1000 K (temperature of the sink in this case). Calculate x . 3

Or

Write down the working principle of heat engines. Obtain the coefficient of performance of a refrigerator.

3. (a) Deduce the following Maxwell's thermodynamical relations : 3×2=6
 (i) $\left(\frac{\partial T}{\partial P}\right)_S = \left(\frac{\partial V}{\partial S}\right)_P$
 (ii) $\left(\frac{\partial T}{\partial V}\right)_S = -\left(\frac{\partial P}{\partial S}\right)_V$
- (b) What are the conditions of reversibility of a thermodynamic process? State the second law of thermodynamics. 1+2=3
4. What is entropy? Show that entropy remains constant in reversible processes but increases in irreversible processes. 1+2+2=5
5. (a) What do you understand by first and second order phase transitions? Discuss with examples. 2+2=4
 (b) Write the equation for second order phase transition. 2

Or

Explain the third law of thermodynamics in brief.

6. (a) Write the expression for Maxwell's velocity distribution function and from it, determine the most probable speeds. 1+3=4
- (b) Using the law of equipartition of energy, show that the specific heat per mole is $C_v = \frac{5}{2}R$. 2
7. On the basis of kinetic theory of gases, deduce an expression for the viscosity of a gas in terms of mean free path of its molecules. Show that it is independent of pressure and depends upon the temperature of the gas. 4
8. (a) Derive the van der Waals equation of state. Calculate the critical constant of a gas in terms of the van der Waals equation. 5
- (b) Discuss about Joule-Thomson effect of real and van der Waals gases. Distinguish between Boyle's temperature and temperature of inversion. 2+2=4

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3 SEM TDC PHYH (CBCS) C 7

2 0 2 1

(Held in January/February, 2022)

PHYSICS

(Core)

Paper : C-7

(Digital Systems 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 option : 1×5=5

- (a) In a CRT, the focus can be controlled by
- (i) adjusting the positive potential of the anode
 - (ii) adjusting the negative potential of the grid
 - (iii) adjusting the d.c. potential of the horizontal deflection plates
 - (iv) adjusting the d.c. potential of the vertical deflection plates

(2)

(b) The binary equivalent of the decimal number 52.875 is

(i) 100110.101

(ii) 100100.110

(iii) 110100.111

(iv) 111010.011

(c) The maxterm which is missing in the expression $A(\bar{B} + A)B$ is

(i) M_0

(ii) M_1

(iii) M_2

(iv) M_3

(d) Which of the following is **not** correct?

(i) $\overline{A \oplus B} = \bar{A} \oplus B$

(ii) $A \oplus B = \bar{A} \oplus \bar{B}$

(iii) $A + BC = (A + B)(A + C)$

(iv) $A \oplus \bar{A} = 0$

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(Continued)

(3)

(e) When a flip-flop is reset, its outputs will be

(i) $Q = 0, \bar{Q} = 0$

(ii) $Q = 1, \bar{Q} = 0$

(iii) $Q = 0, \bar{Q} = 1$

(iv) $Q = 1, \bar{Q} = 1$

2. Draw the block diagram of a general purpose CRO and mention the different parts. 2

3. What are different scales of integration? Mention the number of components in each scale of integration. 2

4. (a) Describe how NAND gate can be used to realize XOR gate. 3

(b) Draw the logic diagram and write the truth table of an even parity bit generator using XOR gate (consider 4-bit input). 2

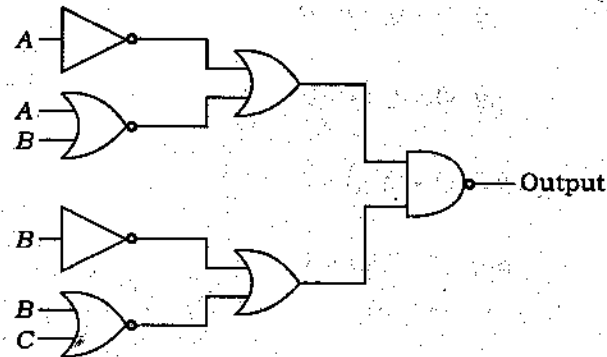
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(Turn Over)

(4)

5. Draw the simplest possible logic diagram that implements the output of the logic diagram shown below :

3



Or

Reduce the expression $f = \sum m(0, 2, 3, 4, 5, 6)$ using K-map and implement it using AOI logic. 2+1=3

6. Draw the logic diagram of a decimal to BCD encoder and explain its working. 2+2=4
7. (a) Describe the 2's complement method of subtraction. 2
- (b) What is half adder? Draw the logic diagram for half adder using only NAND gates. 1+2=3

22P/96

(Continued)

(5)

8. How does a *J-K* flip-flop differ from an *S-R* flip-flop in its operation? Draw the logic diagram of an active-high *S-R* latch using only NAND gates and describe its operation.

1+3=4

Or

What is race around condition in flip-flop? Explain how master-slave flip-flops can eliminate this condition. 1+3=4

9. Draw the functional block diagram of an IC-555 and explain the function of each pin. 3
10. Draw the logic diagram of 4-bit serial-in, parallel-out shift register using *D* flip-flops. 2
11. What is ring counter? Describe the working of a 4-bit ring counter. 1+3=4

Or

What is synchronous counter? Describe the procedure for systematic design of any synchronous counter. 1+3=4

12. (a) What are different types of secondary memory? Write one advantage of DDR RAM. 1+1=2
- (b) Explain the functions of different buses present in a computer. 3

22P/96

(Turn Over)

13. (a) What are the various registers of 8085 microprocessor? 2

(b) Describe the different types of addressing modes of 8085 microprocessor. 4

Or

Draw the simplified block diagram of 8085 microprocessor showing the main units. 4

14. Define opcode and operand. Explain the arithmetic instruction of 8085 with example. 1+2=3

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3 SEM TDC MTMH (CBCS) C 5

2 0 2 1

(Held in January/February, 2022)

MATHEMATICS

(Core)

Paper : C-5

(Theory of Real Functions)

Full Marks : 80

Pass Marks : 32

Time : 3 hours

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

1. (a) Define limit of function at a point. 1

(b) Evaluate the following limits (any one) : 2

(i) $\lim_{x \rightarrow 2} \sqrt{\frac{2x+1}{x+3}}$

(ii) $\lim_{x \rightarrow 1} \frac{x-1}{\sqrt{x+3}-2}$

(2)

- (c) If $f : A \rightarrow R$ and if c is a cluster point of A , then prove that f can have only one limit at c . 3

2. (a) Write the type of discontinuity if

$$\lim_{x \rightarrow c^+} f(x) \neq \lim_{x \rightarrow c^-} f(x) \quad 1$$

- (b) When does a function f continuous on a set? 2

- (c) Investigate for the point of discontinuity : 4

$$f(x) = \begin{cases} 1; & \text{if } x \text{ is rational} \\ 0; & \text{if } x \text{ is irrational} \end{cases}$$

Or

Let $A, B \subseteq R$ and let $f : A \rightarrow R$ and $g : B \rightarrow R$ be functions such that $f(A) \subseteq B$. If f is continuous at a point $c \in A$ and g is continuous at $b = f(c) \in B$; then prove that composition $g \circ f : A \rightarrow R$ is continuous at c .

(3)

- (d) Let $A \subseteq R$, let $f : A \rightarrow R$ and let $|f|$ be defined by $|f|(x) = |f(x)|$ for $x \in A$ and f is continuous at a point $c \in A$. Prove that $|f|$ is continuous at c . 3

Or

Discuss the continuity of $f(x) = |x-1| + |x-2|$ in the interval $[0, 3]$.

3. (a) State location of roots theorem. 1

- (b) State and prove intermediate value theorem. 4

- (c) Find the roots of the equation $x^3 - x - 1 = 0$ between 1 and 2 by using location of roots (bisection method) theorem. 4

Or

Let I be a closed bounded interval and let $f : I \rightarrow R$ be continuous on I , then prove that the set $f(I) = \{f(x) : x \in I\}$ is a closed bounded interval.

4. (a) Write the non-uniformity continuity criteria (any one). 1

(4)

- (b) Show that a function $f : \mathbb{R} \rightarrow \mathbb{R}$ given by $f(x) = x^2$ is not uniformly continuous on \mathbb{R} .

4

Or

If f and g are each uniformly continuous on \mathbb{R} , then prove that composite function $f \circ g$ is also uniformly continuous on \mathbb{R} .

5. (a) Find :

$$\frac{d}{dx}(\tan x^2)$$

1

- (b) State Caratheodory's theorem.

2

- (c) If f is continuous on the closed interval $I = [a, b]$ and f is differentiable on the open interval (a, b) and $f'(x) = 0$ for all $x \in (a, b)$, prove that f is constant on I .

3

6. (a) Define relative maximum and relative minimum at a point on an interval.

2

- (b) State and prove Rolle's theorem.

1+3=4

(5)

- (c) Apply the mean value theorem to prove the following (any one) :

4

(i) $e^x \geq 1+x$ for $x \in \mathbb{R}$

(ii) $\frac{b-a}{1+b^2} < \tan^{-1} b - \tan^{-1} a < \frac{b-a}{1+a^2}$
for $a < b$

7. (a) Show that $f(x) = x^3 - 3x^2 + 3x + 2$ is strictly increasing for every value of $x \in \mathbb{R}$ except 1.

2

- (b) Let $I \subseteq \mathbb{R}$ be an interval, let $f : I \rightarrow \mathbb{R}$, let $c \in I$ and assume that f has a derivative at c and $f'(c) > 0$, then there is a number $\delta > 0$. Prove that $f(x) > f(c)$ for $x \in I$ and $c < x < c + \delta$.

3

- (c) Examine the validity of mean value theorem for the function $f(x) = 2x^2 - 7x + 10$ on $[2, 5]$.

4

Or

If f is differentiable on $I = [a, b]$ and if k is a number between $f'(a)$ and $f'(b)$, then prove that there exists at least one point c in (a, b) , where $f'(c) = k$.

8. (a) Write the remainder after n terms of Taylor's theorem in Lagrange's form. 1
- (b) Write the statement of Cauchy's mean value theorem. 2
- (c) Deduce from Cauchy's mean value theorem $f(b) - f(a) = \xi f'(\xi) \log \frac{b}{a}$, where $f(x)$ is continuous and differentiable in $[a, b]$ and $a < \xi < b$. 3
- (d) State and prove Taylor's theorem with Cauchy's form of remainder. 6

Or

Find the approximate value of $\sqrt[3]{1+x}$, $x > -1$ by using Taylor's theorem with $n = 2$.

9. (a) Write the necessary condition for a function $f(x)$ to have relative extremum at $x = c$. 1
- (b) Determine whether or not $x = 0$ is a point of relative extremum of $f(x) = \sin x - x$. 2
- (c) Define convex function. 2

- (d) Using Maclaurin's series, expand the following in an infinite series in powers of x (any two) : $4 \times 2 = 8$

(i) $\log(1+x)$

(ii) $\cos x$

(iii) $\frac{1}{ax+b}$

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3 SEM TDC MTMH (CBCS) C 6

2021

(Held in January/February, 2022)

MATHEMATICS

(Core)

Paper : C-6

(**Group Theory—I**)

Full Marks : 80

Pass Marks : 32

Time : 3 hours

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

1. (a) What is the inverse of the element
13 in Z_{20} ? 1
- (b) List the elements of $U(20)$. 1
- (c) Let G be a group and $a, b \in G$ such that
 $a^3 = e, aba^{-1} = b^2$. Find $O(b)$. 2
- (d) Let G be a group, then prove that
 $(ab)^{-1} = b^{-1}a^{-1}, \forall a, b \in G$ 2

(2)

(e) In D_4 , find all elements X such that

(i) $X^3 = V$

(ii) $X^3 = R_{90}$

(iii) $X^3 = R_0$

(iv) $X^2 = R_0$

4

Or

Construct a complete Cayley table for D_3 .

(f) Prove that the set $G = \{1, 2, 3, 4, 5, 6\}$ is a finite abelian group of order 6 with respect to multiplication modulo 7.

5

2. (a) Let H and K be two subgroups of a group G . Then, write the condition such that $H \cup K$ may be a subgroup of G .

1

(b) Define index of a subgroup in a group.

2

(c) Prove that a non-empty subset H of a finite group G is a subgroup of G iff $HH = H$.

4

(d) Define normalizer of an element in a group G and also show that $N(a)$ is a subgroup of the group G where $a \in G$.

4

(3)

Or

Prove that $O(C(a)) = 1$ if and only if $a \in Z(G)$.

(e) Prove that the relation of conjugacy is an equivalence relation.

4

3. (a) Write all the subgroups of a cyclic group of order 12.

1

(b) State Fermat's little theorem.

1

(c) Prove that a group of prime order has no proper subgroup.

2

(d) Give an example of a cyclic group whose order is not prime.

2

(e) Let G be a group and H be a subgroup of G . Let $a, b \in G$. Then show that

(i) $Ha = Hb$ iff $ab^{-1} \in H$

(ii) Ha is a subgroup of G iff $a \in H$

4

(f) Let H be a subgroup of a finite group G . Then prove that the order of H divides the order of G .

5

(4)

- (g) Prove that an infinite cyclic group has exactly two generators. 5

Or

Prove that the order of a finite cyclic group is equal to the order of its generator.

4. (a) State Cauchy's theorem for finite abelian group. 1
- (b) Prove that quotient group of an abelian group is abelian. 2
- (c) Prove that every subgroup of a cyclic group is normal. 3
- (d) Let H and K be two subgroups of a group G . Then prove that HK is a subgroup of G if K is normal subgroup of G . Also if H and K both are normal subgroups, then HK is also normal subgroup of G . 4
- (e) If G_1 and G_2 are groups, then prove that
- (i) identity is the only element common to $G_1 \times \{e_2\}$ and $\{e_1\} \times G_2$

(5)

- (ii) every element of $G_1 \times G_2$ can be uniquely expressed as the product of an element in $G_1 \times \{e_2\}$ by an element in $\{e_1\} \times G_2$

(iii) $G_1 \times G_2 \cong G_2 \times G_1$ 1+2+2=5

Or

Let H be a subgroup of a group G such that $x^2 \in H, \forall x \in G$. Then prove that H is normal subgroup of G . Also prove that G/H is abelian. 5

5. (a) Let H be a normal subgroup of a group G and $f: G \rightarrow G/H$ such that $f(x) = Hx, \forall x \in G$. Then prove that f is an epimorphism. 2
- (b) Let f be a homomorphism from a group G into a group G' . Then prove that
- (i) $f(a^{-1}) = [f(a)]^{-1}, \forall a \in G$
- (ii) if $O(a)$ is finite, then $O(f(a)) | O(a)$ where $a \in G$ 3
- (c) Let H and K be two normal subgroups of a group G such that $H \subseteq K$. Then prove that $\frac{G}{K} \cong \frac{G/H}{K/H}$ 5

3 SEM TDC MTMH (CBCS) C 7

(6)

2021
(Held in January/February, 2022)

MATHEMATICS
(Core)

Paper : C-7

(PDE and Systems of ODE)

Full Marks : 60

Pass Marks : 24

Time : 3 hours

The figures in the margin indicate full marks
for the questions

1. (a) Write the degree of the equation

$$x \left(\frac{\partial^2 z}{\partial x^2} \right) + \left(\frac{\partial z}{\partial y} \right)^2 = \frac{\partial z}{\partial x}$$

1

- (b) Write Lagrange's subsidiary equation of

$$xzp + yzq = xy$$

1

- (c) Write the general solution of $pq = k$.

1

- (d) Solve :

5

$$(y - zx)p + (x + yz)q = x^2 + y^2$$

Or

Find the integral surface of $x^2 p + y^2 q + z^2 = 0$, which passes through the hyperbola $xy = x + y$, $z = 1$.

- (e) Show that the equations $xp - yq = x$ and $x^2 p + q = xz$ are compatible.

5

- (d) Prove that the necessary and sufficient condition for a homomorphism of a group G onto a group G' with kernel K to be an isomorphism is that $K = \{e\}$. 5

Or

State and prove Cayley's theorem.

2. (a) Write Charpit's auxiliary equations for $q = 3p^2$. 2

(b) Find complete integral of any one of the following : 4

(i) $q = (z + px)^2$

(ii) $q + px = p^2$

(iii) $z^2 = pqxy$

(c) Find a complete integral of $p_1^3 + p_2^2 + p_3 = 1$. 6

Or

Solve the boundary value problem $\frac{\partial u}{\partial x} = 4 \frac{\partial u}{\partial y}$ with $u(0, y) = 8e^{-3y}$ by the method of separation of variables.

3. (a) Write the condition when the equation $Rs + Ss + Tt + f(x, y, z, p, q) = 0$ is hyperbolic. 1

(b) Determine the nature of the equation $\frac{\partial^2 z}{\partial x^2} = x^2 \frac{\partial^2 z}{\partial y^2}$. 2

(c) Show that $u = f(x+y) + g(y-x)$ satisfies the equation $\frac{\partial^2 u}{\partial x^2} - \frac{\partial^2 u}{\partial y^2} = 0$ where f and g are functions. 2

(d) Reduce the equation $\frac{\partial^2 z}{\partial x^2} + x^2 \frac{\partial^2 z}{\partial y^2} = 0$ to canonical form. 7

Or

Derive the one-dimensional heat equation.

4. (a) Write the general form of two-dimensional heat equation. 1

(b) Write one assumption on vibrating string problem. 1

(c) Solve $\frac{\partial^2 u}{\partial x^2} = k^2 \left(\frac{\partial u}{\partial t} \right)$ when $u(0, t) = u(l, t) = 0, u(x, 0) = \sin \frac{\pi x}{l}$. 6

Or

Solve the two-dimensional heat equation by the method of separation of variables.

5. (a) Write the equation $3 \frac{d^2 x}{dt^2} + 6 \frac{dx}{dt} - x = t^2$ in normal form. 1

(b) Let $L \equiv D^2 + 2, f(t) = e^{2t}$, where $D \equiv \frac{d}{dt}$. Find $Lf(t)$. 2

(c) Transform the linear differential equation

$$\frac{d^2x}{dt^2} - 4\frac{dx}{dt} + 2x = t^2$$

into a system of first-order differential equation.

2

(d) Describe Euler's method.

4

Or

Find the characteristic roots of the equation associated in the solution of

$$\frac{dx}{dt} = 3x + y, \quad \frac{dy}{dt} = 4x + 3y$$

(e) Solve :

$$\frac{dx}{dt} + \frac{dy}{dt} - x - 3y = e^t$$

$$\frac{dx}{dt} + \frac{dy}{dt} + x = e^{3t}$$

6

Or

Find $y(0.1)$, $y(0.2)$ in the solution of

$$\frac{dy}{dx} = x + y, \quad y(0) = 1, \text{ by using Runge-Kutta method.}$$

method.
