

Total No. of printed pages = 3

VI SEM BOTC 1

2023

BOTANY (Core)

Paper : BOTC-601

(Plant Metabolism)

Full Marks – 50

Pass Marks – 20

Time – Two hours

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

1. (a) Fill in the blanks : 1×3=3
- (i) Enzyme nitrate reductase converts nitrate into _____.
 - (ii) The most abundant protein on earth is _____.
 - (iii) The full form of UDPG is _____.
- (b) Choose the correct answers : 1×2=2
- (i) Mitochondrial electron transport system consists of II/IV/VI complexes.
 - (ii) The O₂ evolved during light reaction comes out from PSI/PSII/none of these.

[Turn over

2. Write short notes on any *five* : $3 \times 5 = 15$

- (a) Allosteric enzyme.
- (b) Gluconeogenesis.
- (c) Catabolic pathway.
- (d) Antenna molecule and reaction centre.
- (e) Second messenger.
- (f) Structure of chloroplast.

3. (a) Mention different types of dark reactions found in plants. Write about Hatch-Slack cycle found in C_4 plants and also mention its significance. $1+5+2=8$

Or

(b) What are CAM plants ? Describe CAM cycle of carbon fixation found in plants. $1+7=8$

4. (a) What is an EMP pathway ? Write in detail the TCA cycle found in mitochondria. How many ATP molecules are formed during EMP and TCA cycle. $1+5+2=8$

Or

(b) Define oxidative phosphorylation. Describe the chemiosmotic mechanism of oxidative phosphorylation.

5. (a) What do you mean by cyanide sensitive and cyanide resistant respiration ? Describe in brief the cyanide resistant respiration.

$2+5=7$

Or

(b) Write short account on : $3\frac{1}{2} \times 2 = 7$

(i) B-oxidation

(ii) Glyoxylate cycle in plants.

6. Write brief note on any *one* : $7 \times 1 = 7$

(a) Biological nitrogen fixation in Leguminous plants.

(b) Mechanism of signal transduction.

Total No. of printed pages = 3

VI SEM BOTC 2

2023

BOTANY (Core)

Paper : BOTC-602

(Plant Biotechnology)

Full Marks – 50

Pass Marks – 20

Time – Two hours

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

1. (a) Answer the following questions : $1 \times 3 = 3$
 - (i) What does 'R' represents in ECORI ?
 - (ii) What is competence ?
 - (iii) What is gene gun ?

- (b) Choose the correct answers : $1 \times 2 = 2$
 - (i) Organogenesis is formation of callus tissue / formation of root and shoot in callus culture / genesis of organs.
 - (ii) Which of the following plant is free from the attack of the virus stem / root / meristem / leaves.

[Turn over

2. Write short notes on any *five* : $3 \times 5 = 15$

- (a) cDNA libraries.
- (b) Recombinant DNA and its importance.
- (c) GUS.
- (d) Luciferase.
- (e) Complementation.
- (f) Direct gene transfer.
- (g) BAC.
- (h) Circular restriction mapping.

3. Explain the role of restriction endonuclease in recombinant DNA technology. 5

4. Write in detail about the role of transgenics in bioremediation. 5

5. (a) Discuss in detail the application of biotechnology in the production of improved horticultural varieties. 6

Or

(b) Explain the steps involved in the production of humulin. 6

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

$7 \times 2 = 14$

- (a) Write in detail about the components of plant tissue culture methods.
- (b) Discuss in brief the benefits of plant tissue culture in regards to plant pathology.
- (c) How will you isolate protoplast from the plant cell ? Describe Protoplast culture mentioning its application.

Total No. of printed pages = 3

VI SEM BOTD 1

2023

BOTANY (DSE)

Paper : BOTD-601

(Bioinformatics)

Full Marks – 50

Pass Marks – 20

Time – Two hours

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

1. Fill in the blanks : 1×5=5
- (a) _____ is a biological database retrieval system.
 - (b) EMBL stands for _____.
 - (c) BLOSUM stands for _____.
 - (d) A software used for phylogenetic analysis is _____.
 - (e) BLAST is a _____ alignment search tool.

[Turn over

2. Write short notes on any *three* : $5 \times 3 = 15$

(a) PAM.

(b) Scope and research areas of bioinformatics

(c) DDBJ

(d) MSA by CLUSTALW

(e) Application of bioinformatics in crop improvement.

3. What are the different branches of bioinformatics ? Describe the classification format of biological databases. $3+4=7$

4. (a) What is NCBI ? What are the tools and databases of NCBI ? Describe the process of sequence submission to NCBI. $1+3+6=10$

Or

(b) What is PIR ? Write short note about PIR, resources of PIR and databases of PIR. $1+3+3+3=10$

5. (a) What is sequence alignment ? Differentiate between pair wise and multiple sequence alignment. Describe the process of MSA by CLUSTALW. $1+2+4=7$

Or

(b) Describe the different softwares used for phylogenetic analysis. 7

6. (a) Write an account on the applications of bioinformatics in drug designing. 6

Or

(b) Write a short note on QSAR. 6

Total No. of printed pages = 3

VI SEM BOTD 2

2023

BOTANY (DSE)

Paper : BOTD-602

(Plant Breeding)

Full Marks – 50

Pass Marks – 20

Time – Two hours

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

1. (a) Choose the correct answers : $1 \times 3 = 3$
- (i) Breeding for improved nutritional quality is referred to as bioming/biofortification/biomagnification.
 - (ii) Raphanobrassica is an example of intraspecific/intergeneric/interspecific hybrid.
 - (iii) Polyploidy is induced through mutagenic chemicals/ethylene/colchicine.

[Turn over

(b) Fill in the blanks : $1 \times 2 = 2$

(i) The quickest method of plant breeding is ____.

(ii) Emasculation is essential in ____ flowers.

2. Answer the following questions : $3 \times 2 = 6$

(a) State the different modes of asexual reproduction in plants.

(b) What are the undesirable consequences of plant breeding.

3. Write short notes on any *three* : $5 \times 3 = 15$

(a) Acclimatization

(b) Polygenic inheritance

(c) Applications of heterosis

(d) Role of mutations in crop improvement

(e) Disadvantages of hybridization.

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

$8 \times 3 = 24$

(a) What is plant breeding? Write about its objectives and important achievements. 8

(b) What is selection? Write about mass and pure-line selection. $1 + 3\frac{1}{2} + 3\frac{1}{2} = 8$

(c) What do you mean by monogenic inheritance? Write about the mechanism of quantitative inheritance with suitable example. $1 + 4 + 3 = 8$

(d) What is hybrid? Write about the genetic basis of heterosis. $1 + 7 = 8$

(e) What do you mean by distant hybridization? Describe in brief the role of biotechnology in crop improvement. $2 + 6 = 8$

Total No. of printed pages = 6

VI SEM CHMC 1

2023

CHEMISTRY (Core)

Paper : CHMC-601

(Inorganic Chemistry – IV)

Full Marks – 50

Pass Marks – 20

Time – Two hours

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

1. Choose the correct options (any *five*): $1 \times 5 = 5$
 - (a) Which of the following statement(s) is/are correct regarding interfering radical in the qualitative analysis?
 - A. They interfere the analysis of basic radicals in basic medium only.
 - B. They do no interfere basic radicals in Group-II analysis because in acidic medium they are found in complete ionised state.

[Turn over

- C. In basic medium, interfering radicals are insoluble and hence form complex with the reagent.
- D. All of the above
- Only A is correct
 - B and C are correct
 - Only C is correct
 - D is correct
- (b) The complex that obey the 18-electron rule is
- $[\text{Mn}(\text{CO})_5]^-$
 - $[(\eta^5 - \text{C}_5\text{H}_5) \text{Co}]$
 - $[\text{Mo}(\text{CO})_3 (\text{CH}_3\text{CN})_3]$
 - $[(\eta^5 - \text{C}_5\text{H}_5)_2 \text{Ti}]$
- (c) The infrared stretching frequency ν_{CO} of the following carbonyls follow the order
- | | |
|---------------------------------|--|
| P. $[\text{Mn}(\text{CO})_6]^+$ | Q. $\text{H}_3\text{B} \leftarrow \text{CO}$ |
| R. CO | S. $[\text{V}(\text{CO})_6]^-$ |
- $\text{Q} > \text{R} > \text{P} > \text{S}$
 - $\text{P} > \text{Q} > \text{R} > \text{S}$
 - $\text{R} > \text{Q} > \text{P} > \text{S}$
 - $\text{Q} > \text{R} > \text{S} > \text{P}$

- (d) Which of the following statement about the ferrocene is false ?
- It obey's ther 18-electron rule
 - It is diamagnetic
 - It is aromatic
 - It resists electrophilic substitution
- (e) In the hydrogenation of alkene using Wilkinson Catalyst, the active catalyst is $\text{RhCl}(\text{PPh}_3)_2$. The first step of the Catalytic cycle is
- Alkene co-ordination
 - Oxidative addition of H_2
 - Loss of PPh_3
 - Loss of Cl^-
- (f) Species present in ether solution of Grignard reagent (Schlenk equilibrium)
- | | |
|---------------------------|---------------------------|
| (i) R_2Mg | (ii) R_2X |
| (iii) RMgX | (iv) All of these |

(g) Which catalyst is used in Wacker's process?

(i) Copper

(ii) Arsenic

(iii) Palladium (II) Chloride

(iv) Silver.

2. Write short answers on any five: $4 \times 5 = 20$

(a) What are the limitations of 18-electron rule. d^8 square planer complexes are stable although they do not obey the 18-electron rule. Explain.

(b) Cyclo pentadienyl ring in non-aromatic but when it is co-ordinated to Fe in ferrocene cyclopentadienyl impart aromaticity, why? Give the reaction of ferrocene with the following:

(i) With CH_3COCl in presence of AlCl_3

(ii) Acetic anhydride in presence of H_3PO_4 .

(c) What are the important structural features of methyl lithium tetramer? Draw the orbital overlap diagram of formation trialkyl aluminium dimer.

(d) Define thermodynamic and kinetic stability of complex. How do these stabilities are related to inertness and lability of a complex?

(e) What is the key point in Fisher-Tropsch Synthesis? Use of iron or cobalt as catalyst in this Synthesis is very effective, why?

(f) What is trans effect? How does trans directing nature of π -acidic ligand can be explained on the basis of π -bonding theory?

(g) Discuss the bonding in following carbonyls in the light of valence bond theory

(i) $[\text{Fe}(\text{CO})_5]$

(ii) $[\text{Mn}_2(\text{CO})_{10}]$

3. Discuss the formation of Zaise Salt in the light of Valence Bond Theory. Explain the following observations: $4+2=6$

(a) Normal bond distance between $\text{C} = \text{C}$ increases in Zaise Salt.

(b) Planarity of $\text{H}_2\text{C} = \text{CH}_2$ molecule in Zaise Salt is distorted.

4. Define A , D , I_d and I_a mechanism in octahedral substitution, Prove that associative (SN_2) mechanism in metal complexes is bimolecular with respect to the metal complex and incoming nucleophile. $2+3=5$

5. What is hydroformylation reaction? Discuss the mechanism of hydroformylation reaction of alkene using HCo(CO)_4 as catalyst. Give the description of each steps according to organometallic reaction type and electron count of each species. 1+4=5

6. Write short notes on (any three): 3×3=9

- π -acceptor behaviour of CO.
- IR-data to explain back bonding in M-CO bond.
- Triethylaluminium in polymerisation of ethene
- Polarisation theory of trans effect.
- Synthesis gas by metal carbonyl complex.

Total No. of printed pages = 7

VI SEM CHMC 2

2023

CHEMISTRY (Core)

Paper : CHMC-602

(Organic Chemistry-V)

Full Marks – 50

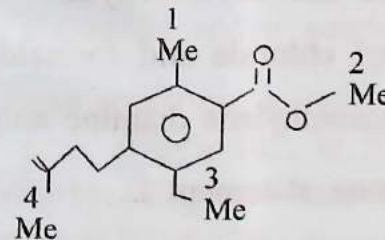
Pass Marks – 20

Time – Two hours

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

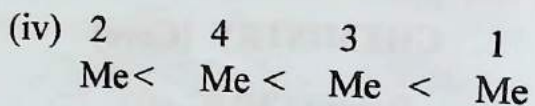
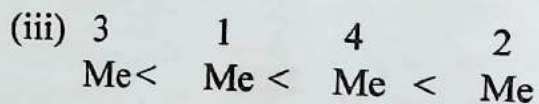
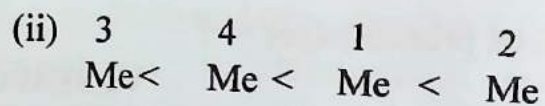
1. Choose the correct answers : 1×5=5

(a) The correct order of ^1H NMR chemical shift (δ) values for the Label groups in the following compound is



(i)

1	2	3	4
Me <	Me <	Me <	Me



(b) The NMR inactive nucleus is



(c) The number of NMR signals produced by cyclohexane at room temperature is



(d) Terelene is a polymer of

(i) Ethylene glycol and terephthalic acid

(ii) Urea and formaldehyde

(iii) Vinyl chloride and formaldehyde

(iv) Hexamethylene diamine and adipic acid

(e) The wrong statement is

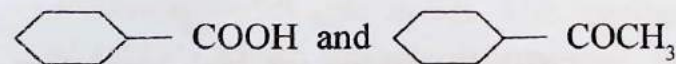
(i) A synthon is an intermediate in actual synthesis.

(ii) A synthon may or may not be an intermediate in actual synthesis.

(iii) A synthon always has a corresponding reagent (SE).

(iv) A bond can be disconnected with or without going through FGI.

2. (a) How would you differentiate the compounds of the following pair by using IR spectroscopy? 2



(b) Explain the following :

(i) In a more polar solvent $n \rightarrow \pi^*$ transition experiences a blue shift, but $\pi \rightarrow \pi^*$ transition a red shift. 3

(ii) PMR spectrum of methanol in carbon tetrachloride shows two singlets, but in deuterated dimethyl sulphoxide, it shows a doublet and a quartet. 2

3. (a) In mass spectrum, a hydrocarbon shows an M^+ peak at m/z 102. In PMR spectrum, it shows two singlets – one at $\delta 7.4$ (5H) and another at $\delta 3.08$ (1H). Suggest a structure for the hydrocarbon. 2

(b) By IR Spectroscopy differentiate the following (any one): $2 \times 1 = 2$

(i) The products formed by 2, 3-dimethyl-2-chlorobutane on dehydrohalogenation,

(ii) The isomers of Stilbene.

(c) (i) Alkynic protons show PMR signal at upfield than the alkenic protons. Give an explanation. 3

Or

(ii) By taking the high resolution ^1H NMR spectrum of chloroethane as an example explain the phenomenon of Spin-spin coupling. 3

4. (a) Determine the structure of the compound of molecular formula $\text{C}_4\text{H}_7\text{NO}$ consistent with the following set of spectral data :

UV : $\lambda_{\text{max}} 220\text{nm}$, $\epsilon_{\text{max}} 63$

IR : $3500\text{ cm}^{-1}(\text{m})$, $3402\text{ cm}^{-1}(\text{m})$,
 $2960\text{ cm}^{-1}(\text{w})$, $1682\text{ cm}^{-1}(\text{S})$

and 1610 cm^{-1} .

NMR : $\delta 1.0$ (doublet, 6H), $\delta 2.1$ (septet, 1H)
and $\delta 8.1$ (singlet, 2H). 4

(b) Conjugation shifts UV band ($\pi \rightarrow \pi^*$) to longer wavelength. Explain. 2

5. (a) Synthesise the following (any two): $2 \times 2 = 4$

(i) A dye used as an acid-base indicator.

(ii) An anthraquinone dye.

(iii) A dye from Michler's Ketone.

(b) Butadiene and β -carotene both consist of carbon-carbon double bonds. The former is colourless while the later is orange red. Explain. 2

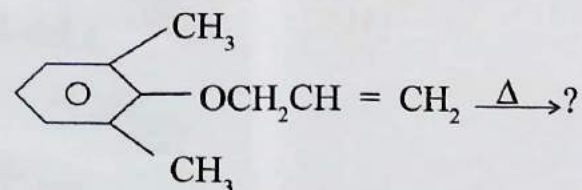
6. (a) Write short notes on (any two): $2 \times 2 = 4$

(i) Ziegler-Natta polymerisation.

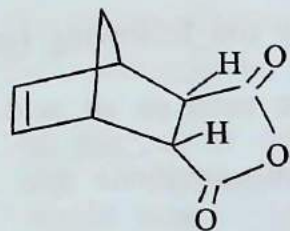
(ii) Vulcanization of rubber.

(iii) Biodegradable polymers.

(b) What is Sigmatropic reaction? Completing the following reaction suggest a mechanism for it. $1+2=3$



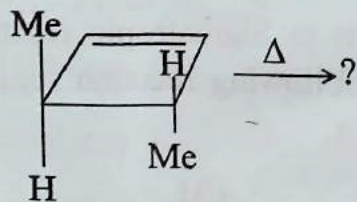
7. (a) Identify the SEs involved in the synthesis of the following compound : 2



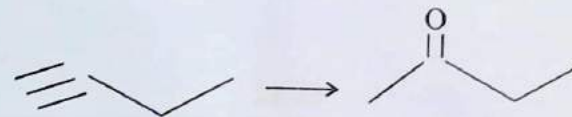
- (b) (i) Explain that Diels-Alder addition is photochemically forbidden while [2+2] cycloaddition is photochemically allowed. 3

Or

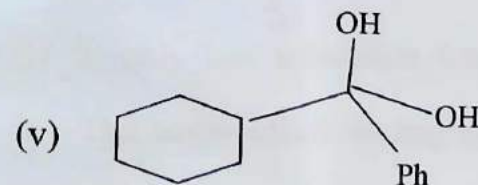
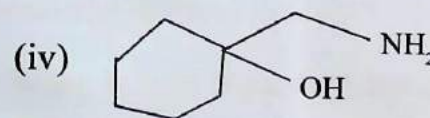
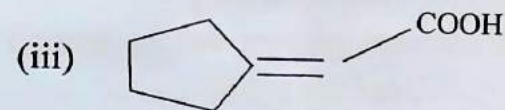
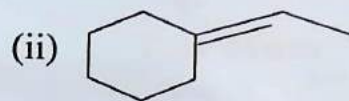
- (ii) How can you convert trans 5, 6, - dimethyl - 1, 3-cyclohexadiene into its Cis isomer? Write down the product formed in the following reaction's : 2+1=3



8. (a) How can the following FGI be carried out? 1



- (b) Synthesise the following with proper retrosynthetic analysis (any three) : 2×3=6



Total No. of printed pages = 6

VI SEM CHMD 1

2023

CHEMISTRY (DSE)

Paper : CHMD-601

(Industrial Chemicals and Environment)

Full Marks – 50

Pass Marks – 20

Time – Two hours

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

1. Choose the correct answers : 1×5=5
- (a) What is true regarding toxicity of Potassium dichromate ?
- (i) It only has inhalation toxicity.
 - (ii) The toxic effect is negligible.
 - (iii) Exposure does not affect the skin.
 - (iv) It is a carcinogen.

[Turn over

- (b) The coldest region of atmosphere is
- (i) Troposphere
 - (ii) Stratosphere
 - (iii) Mesosphere
 - (iv) Thermosphere
- (c) The heating of earth's atmosphere due to trapped radiation is known as
- (i) Global warming
 - (ii) Glass-House effect
 - (iii) Thermal effect
 - (iv) Greenhouse effect
- (d) Which of the following techniques is used for reducing Total Dissolved Solids (TDS) in water ?
- (i) Osmosis
 - (ii) Ion exchange
 - (iii) Distillation
 - (iv) Both (i) and (ii)
- (e) What is the major problem in nuclear power plants ?
- (i) Drawing out energy
 - (ii) Fusion of particles
 - (iii) Disposal of nuclear wastes
 - (iv) Handling of fuel

2. Answer any *two* questions from the following : $2 \times 2 = 4$
- (a) Describe the various stages involved in the manufacture of sulphuric acid.
 - (b) What are the common and industrial uses of common salt.
 - (c) Give few uses and hazards involved in handling potassium dichromate.
 - (d) Write the formula of borax ? Give its few applications.
3. Answer any *two* from the following : $4 \times 2 = 8$
- (a) Describe in brief the cryogenic air separation process for production of Nitrogen, Oxygen and Argon.
 - (b) Discuss the problem of storage, handling and hazards associated with carbon monoxide.
 - (c) Discuss any one method for production of chlorine gas. Mention few uses of the gas.
 - (d) Differentiate between ferrous and non-ferrous metals with examples. Give their uses.
 - (e) Write a short note on ultra pure metal. Mention about its uses.

4. Answer any *three* from the following : $4 \times 3 = 12$

(a) Discuss about the chemical and photochemical reactions taking place in the atmosphere for any one of the following gases :

(i) Oxygen and Ozone chemistry

(ii) Sulphur dioxide

(iii) Nitrogen oxide.

(b) Trace the role of chlorofluorocarbons (CFC) and organic compounds in the atmosphere.

(c) What are particulates? Name the common particulate pollutants that are present in the atmosphere. What are its sources? Give a brief account of the toxic effects of particulates.

(d) Name the common air pollutants. How are they monitored?

(e) What are the natural and human sources of CO whose emission causes air pollution? What is meant by the term 'Sink'? What are the toxic effects of CO?

5. Answer (i) and any *two* from the rest :

$3 + 5 \times 2 = 13$

(i) (a) List the different categories of water quality parameters. 3

Or

(b) Give the various characteristics of Potable water. 3

(ii) Discuss briefly how various agents can cause pollution of water.

(iii) Describe the advanced waste water treatment processes to improve the quality of waste water.

(iv) What type of pollutants are present in the waste water obtained from the following industries?

(1) Food processing industry

(2) Textile industry

(3) Paper and pulp industry

(4) Chemical industry

(5) Petroleum industry

(6) Metal industries

(v) Describe the different methods of sludge disposal.

6. Answer any *four* from the following : $2 \times 4 = 8$

(a) What are the advantages and disadvantages of solid coal ?

(b) What is Syn fuels ? Compare their advantages and disadvantages.

(c) What is natural gas ? Discuss the advantages and disadvantages of natural gas.

(d) What do you mean by non-conventional energy ? Write about its sources.

(e) Discuss the effect of radiation on human health.

(f) What is biocatalysis ? Compare biocatalysis with chemical catalysis.

(g) Examine the role of Biocatalysis as a Green Process.

Total No. of printed pages = 4

VI SEM ELTC 1

2023

ELECTRONIC SCIENCE (Core)

Paper : ELTC-601

(Communication Electronics)

Full Marks – 50

Pass Marks – 20

Time – Two hours

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

1 Answer any *five* questions as directed : $1 \times 5 = 5$

(a) The expression for signal to noise ratio is

(i) $\left(\frac{V_s}{V_n}\right)^2$ (ii) $\left(\frac{V_s}{V_n}\right)$

(iii) $\left(\frac{V_s}{V_n}\right)^3$ (iv) None of these

(Choose the correct options)

- (b) Modulation is done in
- (i) transmitter (ii) receiver
 - (iii) both in transmitter and receiver
 - (iv) None of these
- (Choose the correct options)

(c) What is coding ?

(d) Write one advantage of pulse modulation system.

(e) What is bit rate ?

(f) In single side band system _____ of power is saved. (Fill in the gap)

- (i) $\frac{2}{3}$ (ii) $\frac{1}{3}$
- (iii) $\frac{1}{2}$ (iv) None of these

(Choose the correct options)

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

(a) Draw the block diagram of electronic communication system.

(b) Write at least two methods to achieve Double Side Band Suppressed Carrier (DSBC).

(c) Write the sampling theorem of electronic communication system.

(d) Draw the binary waveform of PSK.

(e) Write the significance of modulation index.

3. Draw the electromagnetic spectrum from cosmic rays to radio waves. Write two applications of X-rays. $5+2=7$

4. (a) What is modulation ? Discuss the generation of amplitude modulation with proper circuit diagram and waveforms. $1+2+2+1=6$

(b) Draw the block diagram of FM transmitter. 4

5. (a) Write short note on any *one* : $4 \times 1 = 4$

(i) pulse code modulation

(ii) pulse duration modulation.

(b) Distinguish between uniform and non-uniform quantization. 2

(c) Explain the concept of companding in communication electronics. 2

6. (a) Draw the block diagram of digital transmission and reception system. 2+2=4

(b) Discuss frequency shifting keying with proper waveforms. Write one drawback of this system. 5+1=6

Total No. of printed pages = 3

VI SEM ELTC 2

2023

ELECTRONIC SCIENCE (Core)

Paper : ELTC-602

(Photonics)

Full Marks – 50

Pass Marks – 20

Time – Two hours

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

1 Answer any *five* questions as directed : $1 \times 5 = 5$

(a) What is refractive index ?

(b) Define reflection coefficient.

(c) State Huggen's Fresnel principle of diffraction of light.

(d) A wave in which every particle of medium oscillates up and down at right angle to the direction of wave propagation is called

(i) Longitudinal wave

(ii) Transverse wave

(iii) None of the above

(iv) Both of above

(Choose the correct option)

[Turn over

- (e) Write one application of laser.
- (f) For an optical fibre, if refractive index of core is μ_1 and refractive index of cladding is μ_2 then
- $\mu_1 > \mu_2$
 - $\mu_1 < \mu_2$
 - $\mu_1 = \mu_2$
 - None of these
- (Choose the correct option)
2. Answer the following questions : $2 \times 5 = 10$
- Give the conditions of sustained interference.
 - What is resolving power of microscope ?
 - Distinguish between polarised and unpolarised light.
 - Define spontaneous and stimulated emission.
 - Discuss the concept of effective index related to guided wave.
3. (a) Discuss the Newton's ring experiment of interference of light and write down the condition for bright and dark rings. $2+2+1+1=6$
- (b) Discuss the Fraunhofer diffraction by double slit method. 4

4. (a) Discuss the circularly polarised light and elliptically polarised light. $2+2=4$
- (b) Define polariser and analyser. How can linearly polarised light be produced using a polariser? $1+1+3=5$
5. (a) Discuss the principle of LCD. 4
- (b) Explain the construction and working of semiconductor injected laser diode. $2+3=5$
6. (a) Write short note on any one : $5 \times 1 = 5$
- TE modes in symmetric slab wave guides.
 - Attenuation in optical fiber.
- (b) Define group velocity of waves. 2

Total No. of printed pages = 3

VI SEM ELTD 1

2023

ELECTRONIC SCIENCE (DSE)

Paper : ELTD-601

**(Semiconductor Fabrication and
Characterization)**

Full Marks – 50

Pass Marks – 20

Time – Two hours

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

- 1 Answer any *five* questions as directed : $1 \times 5 = 5$
- (a) UV-Vis spectra are used to study the _____
of the material. (Fill in the gap.)
- (i) structure
 - (ii) functional group
 - (iii) band gap
 - (iv) None of these
- (b) Give one example of crystalline materials.

[Turn over

(c) The expression for Fick's diffusion equation is

$$(i) \frac{\partial^2 c}{\partial t} = D \frac{\partial^2 c}{\partial t^2} \quad (ii) \frac{\partial^2 c}{\partial t^2} = D \frac{\partial^2 c}{\partial t^2}$$

$$(iii) \frac{\partial c}{\partial t} = D^2 \frac{\partial c}{\partial t} \quad (iv) \text{None of these}$$

(Choose the correct option)

(d) What is Photolithography ?

(e) Which of the following is the active component.

(i) transistor (ii) resistor

(iii) inductor (iv) None of these

(Choose the correct option)

(f) What is the wavelength of X-rays ?

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

(a) What are the two starting materials of GaAs crystal growth process ?

(b) Write at least two methods of oxidation process.

(c) Why do we need a clean room for IC fabrication ?

(d) Distinguish between NMOS and PMOS.

(e) Write two differences between bipolar junction transistor and discrete transistor in an IC.

3. (a) Discuss the Czochralski technique of crystal growth with proper diagram. $3+2=5$

(b) Write short note on any one : $5 \times 1 = 5$

(i) Epitaxial growth by vapour phase epitaxy.

(ii) Epitaxial growth by molecular beam epitaxy.

(c) What is scanning electron microscopy ? Give two applications of it. $1+2=3$

4. (a) Discuss the kinetics of growth for thick and thin oxide during the thermal oxidation process. 5

(b) Discuss the diffusion principle of dopant atoms. 5

5. (a) Discuss electron beam lithography with proper diagram. $3+2=5$

(b) Explain the dry etching process of semiconductor processing. 3

6. Discuss the integrated circuit capacitor with proper diagram. $2+2=4$

Total No. of printed pages = 3

VI SEM GEOC 1

2023

GEOLOGY (Core)

Paper : GEOC - 601

(Engineering Geology)

Full Marks – 50

Pass Marks – 20

Time – Two hours

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

1. Answer the following questions as directed :

1×5=5

- (a) Geographical investigation is usually carried out in the pre-feasibility stage of site investigation. (Write True or False)
- (b) A long anchor bolt employed to reduce rock deformation during tunnel excavation, is known as _____. (Fill in the blank)
- (c) The top flow line in a saturated soil mass below which seepage takes place in a homogeneous embankment dam, is called _____. (Fill in the blank)

[Turn over

- (d) The Mercalli Scale is used to measure the _____ of the earthquake (intensity magnitude) (Choose the correct answer)
- (e) The presence of closely spaced joint and fractures do not cause tunnel overbreak (Write True or False)
2. Write very short notes on : $2 \times 3 = 6$
- Rock mass rating
 - Rolled fill dam
 - Arch bridge.
3. Discuss the rock mass classification of any one of the following : $5 \times 1 = 5$
- Terzaghi's rock mass classification
 - Q-system.
4. What are the basic procedures applied for suitable engineering site selection? Discuss the basic objectives of site investigation. $3+3=6$
5. (a) How is a foundation stabilized through grouting? Write the application of grouting in reducing liquifaction of soil. $2+4=6$
- Or
- (b) Write the significance of rock bolting. Briefly discuss the mechanism of rock bolting. $1+5=6$
6. What is Composite dam? Explain the role of either hydrogeology or environmental consideration for suitability of reservoir. $1+5=6$
7. Explain how geological structures of an area influence the site selection of a tunnel. 5
8. (a) What are the causes of earthquake? Discuss the plate boundaries in the Circum-Pacific Belt. $3+3=6$
- Or
- (b) What is debris flow? Discuss the different types of landslides based on movement. $1+5=6$
9. Which two districts will be connected by the tunnel that is under construction to bypass the Sela pass in Arunachal Pradesh? Discuss the key structural features which influence the major engineering constructions in Eastern Himalaya. $1+4=5$

Total No. of printed pages = 4

VI SEM GEOC 2

2023

GEOLOGY (Core)

Paper : GEOC - 602

(Remote Sensing and GIS)

Full Marks – 50

Pass Marks – 20

Time – Two hours

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

1. Fill in the blanks : 1×5=5
 - (a) The line traced on the ground directly beneath the aircraft during acquisition of aerial photograph is called _____.
 - (b) The spatial resolution of the visible bands in LISS IV is _____.
 - (c) The optical sweep of an across track scanner to cover an area slightly to the west of the previous sweep is known as _____ distribution.

[Turn over

(d) A Secant conical projection has _____ number of standard parallels.

(e) The UTM zone representing the North-Eastern States of India is _____.

2. Write short notes on : $2 \times 3 = 6$

(a) Active and Passive Sensor

(b) Ratio Image

(c) GPS constellation Design.

3. Answer the following : $3 \times 3 = 9$

(a) What is Photographic Scale. Determine the photo scale of an object having elevation of 1200m above mean sea level assuming that the photograph was taken from a flying height of 500m above sea level with a camera of 152mm focal length.

(b) Discuss briefly the characteristics of Raster and Vector data formats.

(c) Discuss the radiometric correction of satellite image.

4. (a) What is Image Parallax and Parallax Displacement? With the help of neat diagram deduce the equation for height of an object from parallax measurement. $2 + 4 = 6$

Or

(b) Discuss briefly the identification of aolian, glacial and fluvial land forms using aerial photograph. 6

5. (a) Discuss the interaction of electromagnetic energy with the atmosphere and earth's surface features. 6

Or

(b) Write a brief note on the progressive development of Indian Remote Sensing Satellites. 6

6. (a) What are the different types of Image errors. Discuss the Geometric correction of Satellite Images. $3 + 3 = 6$

Or

(b) With the help of neat diagrams, discuss the different classifiers used in image classification. 6

7. (a) What are the different types of map projection based on the projection surface used. 6

Or

(b) What is coordinate system? Write briefly on Geographic Co-ordinate system. $1 + 5 = 6$

8. (a) What do you mean by GPS? Discuss the different segments of GPS. 1+5=6

Or

- (b) Write a note on application of GPS. 6

Total No. of printed pages = 3

VI SEM GEOD 1

2023

GEOLOGY (DSE)

Paper : GEOD - 601

(Fuel Geology)

Full Marks – 50

Pass Marks – 20

Time – Two hours

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

UNIT – I

(Coal)

1. Write briefly on any *two* of the following : 3×2=6
 - (a) Diagenesis of Coal
 - (b) Cannel Coal
 - (c) Three evidences of “in situ” origin of coal.
2. Write briefly on macerals derived from wood and cortex of plants. 6

[Turn over

UNIT - II
(Coal as a Fuel)

3. Fill in the blanks : $1 \times 2 = 2$
- (a) The CBM initially diffuses through coal matrix and micropores towards fracture system, following _____ Law of Diffusion.
- (b) _____ reflectance is commonly used as a measure of thermal maturity in coal.
4. What do you mean by "liquefaction of coal"? Discuss briefly two important methods of coal liquefaction. $1 + 1\frac{1}{2} + 2\frac{1}{2} = 6$

UNIT - III
(Petroleum)

5. What is maturation of kerogen? Why is it important to study? Discuss some important maturity indicators for kerogen. $1 + 2 + 4 = 7$
6. Write short note on any one of the following: $3 \times 1 = 3$
- (a) Oil Window
- (b) Types of petroleum.

UNIT - IV
(Petroleum Reservoir And Trap)

7. Answer the following questions as directed : $1 \times 2 = 2$
- (a) Heavy oil is formed in _____ plate boundaries. (Fill in the blank)
- (b) Which rock shows maximum ductility in Downey's table.
8. Write short notes on any two of the following : $3 \times 2 = 6$
- (a) Dilatancy as a cause of petroleum migration.
- (b) Hydrodynamic trap.
- (c) How does "dolomitization" assist in formation of primary stratigraphic trap.
9. What is a reservoir? Discuss the different reservoir properties of a commercially profitable reservoir. $1 + 5 = 6$

UNIT - V
(Other Fuels)

10. What are the names of important isotopes of nuclear minerals, used as fuel? Discuss the major processing steps necessary before sending Uranium to reactor. $2 + 4 = 6$

Total No. of printed pages = 3

VI SEM GEOD 2

2023

GEOLOGY (DSE)

Paper : GEOD - 602

(River Science)

Full Marks – 50

Pass Marks – 20

Time – Two hours

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

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

(a) What is river discharge ?

(b) Which of the following is similar with river basin boundary ?

(i) Thalweg

(ii) Divide

(iii) Neck cut

(iv) None of these

(Choose the correct answer)

[Turn over

Total No. of printed pages = 6

VI SEM MTHC 1

2023

MATHEMATICS (Core)

Paper : MTHC - 601

(Metric Spaces And Complex Analysis)

Full Marks – 80

Pass Marks – 32

Time – Three hours

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

1. Answer the following questions : 1×5=5
- (a) What is the derived set of $(0, 1)$ under the usual metric over \mathbb{R} ?
 - (b) Write the Open Sphere for usual metric over \mathbb{R} .
 - (c) Define dense set.
 - (d) Write the condition for a non-empty set of \mathbb{R} with usual metric to be connected.
 - (e) Give an example of a mapping which is continuous but not uniformly continuous in a metric space.

[Turn over

2. Answer any *five* of the following questions :
 $2 \times 5 = 10$

(a) Describe Open Sphere of unit radius and centre $(0, 0)$ over \mathbb{R}^2 defined by

$$d_1(z_1, z_2) = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

$$\text{where } z_1 = (x_1, x_2)$$

$$z_2 = (y_1, y_2)$$

(b) Prove that in a discrete metric space every set is open.

(c) Prove that $A^\circ \subseteq A \subseteq \bar{A}$ where A° and \bar{A} are the interior and closure of A respectively.

(d) Give an example to show that every Cauchy Sequence is not convergent in a metric space.

(e) Define open cover. Write an open cover for $X = (0, 1)$ with the usual metric.

(f) Prove that every open sphere is an open circle.

(g) If $f : X \rightarrow Y$ is a homeomorphism from a metric space X to a metric space Y then prove that $G \subseteq X$ is open if and only if its image $f(G) \subseteq Y$ is open.

3. Answer any *four* of the following questions :
 $5 \times 4 = 20$

(a) In a metric space, prove that complement of a finite set is open.

(b) Let A be a subset of a metric space then prove that A is closed if and only if it contains all its limit points.

(c) Let (X, d) be a metric space and $A \subseteq X$. Then $x \in X$ is a limit point of A if and only if there exists a sequence $\{x_n\}$ of points in A , none of which is equal to x such that $\lim_{n \rightarrow \infty} x_n = x$.

(d) State and prove Cantor's theorem.

(e) Let $f : X \rightarrow Y$ be a mapping from a metric space X to Y . Then f is continuous if and only if inverse image of open set in Y is open in X .

(f) Prove that every compact subset F of a metric space is closed.

(g) Let Y be a subset of a metric space (X, d) . Then prove that Y is connected if and only if it can not be expressed as disjoint union of two non-empty closed set in Y .

(h) A non-empty subset X of \mathbb{R} with usual metric is connected if and only if X is an interval or singleton.

4. Answer the following questions : $1 \times 5 = 5$

- (a) Define Jordan arc.
- (b) Write the necessary condition for $f(z)$ to be analytic.
- (c) Define Simply connected domain.

(d) Show that $\lim_{n \rightarrow \infty} \left[-1 + \frac{i(-1)^n}{n^2} \right] = -1$.

- (e) "The absolute convergence of a series of complex numbers implies the convergence of that series". — (State true or false)

5. Answer any *four* of the following questions : $2 \times 4 = 8$

(a) Find $\lim_{z \rightarrow 1+i} (z^2 - 5z + 10)$

(b) Show that $\lim_{z \rightarrow 0} \frac{z}{\bar{z}}$ does not exist.

- (c) Evaluate the contour integral $\int_c \frac{dz}{z}$ where c is the top half $z = e^{i\theta}$ ($0 \leq \theta \leq \pi$) of the circle $|z| = 1$ from $z=1$ to $z=-1$.

(d) If $\lim_{n \rightarrow \infty} z_n = z$ then show that $\lim_{n \rightarrow \infty} |z_n| = |z|$.

- (e) Define removable singularity. If $f(z) = \frac{\sin z}{z}$ then write one removable singularity of $f(z)$.

6. Answer any *four* of the following questions : $3 \times 4 = 12$

- (a) Prove that $f(z) = \frac{1}{z}$ is not uniformly continuous in the region $|z| < 1$.

- (b) Show that $f(z) = z^2 = x^2 - y^2 + 2ixy$ is differentiable everywhere.

- (c) Prove that if a function is entire and bounded in the complex plane then $f(z)$ is constant throughout the plane.

- (d) Obtain the Maclaurin Series expansion of the function $f(z) = \frac{z}{z^4 + 4}$.

- (e) Prove that $\sum_{n=1}^{\infty} \frac{z^n}{n(n+1)}$ converges absolutely for $|z| \leq 1$.

(f) Find the Laurent's series of $\frac{e^{2z}}{(z-1)^3}$ about $z = 1$.

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

(a) Prove that $u = e^{-x}(x \sin y - y \cos y)$ is harmonic.

(b) Find the numbers $z = x + iy$, such that $e^z = 1 + \sqrt{3}$.

(c) State and prove Cauchy's integral formula for a simply connected region.

(d) Prove that any polynomial $p(z) = a_0 + a_1z + a_2z^2 + \dots + a_nz^n$ ($a_n \neq 0$) of degree n ($n \geq 1$) has atleast one zero.

(e) Expand $f(z) = \sin z$ in a Taylor's Series about $z = \frac{\pi}{4}$ and also determine the region of convergence.

(f) Verify that the real and imaginary parts of the following function satisfy Cauchy-Riemann equation and thus deduce the analyticity of the function $f(z) = ze^{-z}$.

2023

MATHEMATICS (Core)

Paper : MTHC - 602

(Ring Theory And Linear Algebra - II)

Full Marks - 80

Pass Marks - 32

Time - Three hours

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

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

(a) What do you mean by associates of a polynomial domain ?

(b) Give an example of a primitive polynomial.

(c) Fill in the blank :

$$(W_1 \cap W_2)^0 = \underline{\hspace{2cm}}$$

(d) Prove that $\|\alpha v\| = |\alpha| \|v\|$, where v is a vector and α is a scalar.

(e) Define minimal polynomial.

2. Answer any two questions : $3 \times 2 = 6$

(a) Prove that every Euclidean ring possesses unity element.

(b) If R is an integral domain and F is its field of quotients, then prove that any element $f(x)$

in $F[x]$ can be written as $f(x) = \frac{f_0(x)}{a}$.

(c) If 'a' is a prime element of a UFD R and b, c are any two elements of R , then prove that $a|bc \Rightarrow a|b$ or $a|c$.

3. Answer any two questions : $3 \times 2 = 6$

(a) Prove that the ring of polynomials over a field is a Euclidean ring.

(b) If R is a unique factorization domain and if $f(x), g(x)$ are in $R[x]$, then prove that $c(fg) = c(f)c(g)$, upto units.

(c) Prove that the polynomial domain $F[x]$ over a field is not a field.

4. Answer any two questions : $4 \times 2 = 8$

(a) Prove that the product of two primitive polynomials of a polynomial ring $R[x]$ over a UFD R is a primitive polynomial in $R[x]$.

(b) Show that the polynomial $1+x+\dots+x^{p-1}$, where p is a prime number is irreducible over the field of rational numbers.

(c) State and prove Gauss lemma.

5. Answer any two questions : $4 \times 2 = 8$

(a) If D is an integral domain, then prove that the polynomial ring $D[x]$ is also an integral domain.

(b) Let R be a unique factorization domain. Prove that every non-zero member $f(x)$ of $R[x]$ can be written as $f(x) = gf_1(x)$, where $g = c(f)$ and $f_1(x)$ is primitive.

(c) Prove that every non-zero element of a Euclidean ring is either a unit of the ring or can be written as a product of a finite number of prime elements of the ring.

6. Define dual space of a vector space V . Find the dual basis of the basis set

$B = \{(-1, 1, 2), (1, 0, -3), (2, 1, 0)\}$ for $V_3(\mathbb{R})$.
 $1+4=5$

7. (a) Let V be a finite dimensional vector space over F . Define $\phi: V \rightarrow V^{**}$ such that $\phi(v) = Tv, \forall v \in V$, where

$Tv: V^* \rightarrow F$ such that $Tv(f) = f(v), \forall f \in V^*$. Show that ϕ is an isomorphism. 4

Or

(b) Prove that $R(T^t) = [N(T)]^0$, where T is a linear transformation over some vector space. 4

8. If V is a finite dimensional vector space and W be a subspace of V , then show that $\dim W + \dim W^\circ = \dim V$. 5

9. (a) State and prove Caley Hamilton theorem. 1+5=6

Or

(b) Find the minimal polynomial for the real matrix. 6

$$\begin{bmatrix} -9 & 4 & 4 \\ -8 & 3 & 4 \\ -16 & 8 & 7 \end{bmatrix}$$

10. Let the linear functional on \mathbb{R}^2 is given by $\phi(x,y) = 2x - 5y$. For each linear mapping $T: \mathbb{R}^3 \rightarrow \mathbb{R}^2$, find $[T^t(\phi)](x,y,z)$ where

(a) $T(x, y, z) = (x - y, y + z)$

(b) $T(x, y, z) = (x + y + 2z, 2x + y)$. 2+2=4

11. Answer any two questions : 3×2=6

(a) Let W_1, W_2 be two subspaces of a vector space V . If W_1, W_2 are inner product spaces, show that $W_1 + W_2$ is also an inner product space.

(b) Prove that if S is an orthogonal set of non-zero vectors in an inner product space V , then S is a linearly independent set.

(c) Prove that every inner product space is a metric space.

12. Answer any two questions : 3×2=6

(a) Find the adjoint of linear map $\mathbb{R}^3 \rightarrow \mathbb{R}^3$, defined by $T(x, y, z) = (3x + 4y - 5z, 2x - 6y + 7z, 5x - 9y + z)$.

(b) Show that any operator T is the sum of a self adjoint operator and a skew adjoint operator.

(c) Let $V(F)$ be a vector space. Let E_1 be a projection on R_1 along N_1 and E_2 be a projection on R_2 along N_2 . Assuming that $1 + 1 \neq 0$ in F . Show that $E_1 + E_2$ is a projection iff $E_1 E_2 = E_2 E_1 = 0$.

13. (a) If $\{W_1, W_2, \dots, W_n\}$ is an orthonormal set in V , then prove that

$$\sum_{i=1}^m |\langle w_i, v \rangle|^2 \leq \|v\|^2, \forall v \in V.$$

Or

- (b) Obtain an orthonormal basis for the vectors $\beta_1 = (3, 0, 4)$, $\beta_2 = (-1, 0, 7)$, $\beta_3 = (2, 9, 11)$ in \mathbb{R}^3 equipped with standard inner product.

14. (a) Let T be a linear operator on a finite dimensional inner product space V . If T is self adjoint, show that the co-efficients of its characteristic polynomial are all real.

Or

- (b) Discuss the Gram-Schmidt orthogonalization process.

Total No. of printed pages = 7

VI SEM MTHD 1

2023

MATHEMATICS (DSE)

Paper : MTHD - 601

(Linear Programming)

Full Marks – 80

Pass Marks – 32

Time – Three hours

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

1. Answer the following as directed : $1 \times 7 = 7$
- (a) Who developed the solution of L.P. problem using simplex method?
 - (b) In Big-M method, at any stage all the artificial vector may be driven out from the Basis. (Write true or false)
 - (c) If the Primal problem has an unbounded solution then, what can be said about the solution of dual.

[Turn over

- (d) How many basic assumptions are necessary for all L.P. models ?
- (e) What happens in the dual if the variable in primal is unrestricted in sign ?
- (f) What are the differences between the degenerated and non-degenerated basic feasible solution in a transportation problem.
- (g) All variable in the L.P. Problem must take one negative value. (Write True or False)
2. (a) Write the general L.P. problem with n-decision variable and m-constraints. 2

- (b) Discuss the general structure of an L.P. model. 6

Or

Discuss the limitation of Linear Programming. 6

- (c) Solve the following L.P Problem graphically :

$$\text{Max } Z = 50x_1 + 30x_2 \quad 5$$

$$\text{S.t} \quad \begin{aligned} 2x_1 + x_2 &\geq 18 \\ x_1 + x_2 &\geq 12 \\ 3x_1 + 2x_2 &\leq 34 \\ x_1 + x_2 &\geq 0. \end{aligned}$$

3. (a) If $x_1 = 2, x_2 = 3, x_3 = 1$ be a feasible solution of the L. P. Problem. 4

$$\text{Max } Z = x_1 + 2x_2 + 4x_3$$

$$\text{S.t} \quad 2x_1 + 2x_2 + 4x_3 = 11$$

$$3x_1 + x_2 + 5x_3 = 14$$

$$x_1, x_2, x_3 \geq 0.$$

Then find a Basic feasible solution.

- (b) Solve the following L.P.P using simplex method 7

$$\text{Max } Z = 16x_1 + 17x_2 + 10x_3$$

$$\text{S.t} \quad x_1 + x_2 + 4x_3 \leq 2,000$$

$$2x_1 + x_2 + x_3 \leq 3,600$$

$$x_1 + 2x_2 + 2x_3 \leq 2,400$$

$$x_1, x_2, x_3 \geq 0.$$

- (c) (i) State using two phase method 7

$$\text{Min } Z = x_1 - 2x_2 - 3x_3$$

$$\text{S.t} \quad -2x_1 + x_2 + 3x_3 = 2$$

$$2x_1 + 3x_2 + 4x_3 = 1$$

$$x_1, x_2, x_3 \geq 0.$$

Or

- (ii) Using Big-M method solve the following L.P.P.

$$\text{Min } Z = 5x_1 + 3x_2$$

$$\text{S.t } 2x_1 + 4x_2 \leq 12$$

$$2x_1 + 2x_2 = 10$$

$$5x_1 + 2x_2 \geq 10$$

$$x_1, x_2 \geq 0.$$

7

4. (a) Obtain the dual of the following Primal Problem :

4

$$\text{Min } Z = x_1 + x_2 + x_3$$

$$\text{S.t } x_1 - 3x_2 + 4x_3 = 5$$

$$x_1 - 2x_2 \leq 3$$

$$2x_1 - x_3 \geq 4 \text{ and } x_1, x_2 \geq 0$$

x_3 is unrestricted in sign.

- (b) (i) If the K^{th} constraints of a Primal be an equation, then show that the K^{th} dual variable will be unrestricted in sign.

4

Or

- (ii) Prove that the Dual of the Dual of a given Primal is the Primal itself.

4

- (c) What is the standard form of the Primal of an L.P. Problem ?

2

- (d) Write the statement of fundamental duality theorem.

2

5. (a) What is the rim condition of a transportation problem ?

1

- (b) Define feasible solution and optimal solution of a Transportation Problem.

3

- (c) Discuss any one of the following method :

3

(i) North-West Corner method

(ii) Matrix minima method.

- (d) Find the initial Basic feasible solution of the following problem with the help of lowest cost entry method and Vogel's approximation method and compare both the result.

6

	W_1	W_2	W_3	Supply
O_1	2	7	4	5
O_2	3	3	1	8
O_3	5	4	7	7
O_4	1	6	2	14
Demand	7	9	18	

(e) Mention two property of a loop in a transportation problem.

6. (a) Define any *three* of the following : $2 \times 3 = 6$

(i) Competitive game

(ii) Rectangular game

(iii) Optimal strategy

(iv) Minimax principle

(b) Discuss the main Assumption of the Game theory.

(c) (i) Using the graphical method for solving the following game and find the value of the game :

		Player B			
Player A		B ₁	B ₂	B ₃	B ₄
A ₁		2	2	3	-2
A ₂		4	3	2	6

Or

(ii) Solve the following game by using maximum (minimum) principle whose pay-off matrix are given below :

		Player B			
Player A		B ₁	B ₂	B ₃	B ₄
A ₁		3	-5	0	6
A ₂		-4	-2	1	2
A ₃		5	4	2	3

Determine the strategy selection for each player and value of the game to each player.

Total No. of printed pages = 6

VI SEM MTHD 2

2023

MATHEMATICS (DSE)

Paper : MTHD - 602

(Differential Geometry)

Full Marks – 80

Pass Marks – 32

Time – Three hours

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

1. Answer the following :

(a) For a space curve, show that $1+2=3$

(i) $\vec{r}' \circ \vec{r}'' = 0$

(ii) $\vec{d} = \tau \hat{t} + \kappa \hat{b}$ where $\vec{b}' = \vec{d} \times \hat{b}$.

(b) If C is a curve for which \hat{b} varies differentially with arc length. If C lies on a plane, show that $\tau=0$ at all points. 2

[Turn over

- (c) (i) Find the curvature of the curve

$$\vec{r} = (a \cos t, a \sin t, bt)$$

Also find unit principal normal of this curve. 2+1=3

Or

- (ii) Prove that equation of tangent line at any point on the curve $\vec{r} = \vec{r}(\theta)$ is

$$\frac{X-x}{\dot{x}} = \frac{Y-y}{\dot{y}} = \frac{Z-z}{\dot{z}} \quad 3$$

- (d) (i) Show that the necessary and sufficient condition for the curve to be a straight line is that $\kappa = 0$ at all points. 4

Or

- (ii) Prove that the tangent to the involute is parallel to the principal normal of the given curve. 4

- (e) Find the equation of osculating sphere at (1, 2, 3) point on the curve $\vec{r} = (2t+1, 3t^2+2, 4t^3+3)$. 4

2. (a) "The parametric equation of a surface is unique" (State True or False) 1

- (b) Define regular point on a surface. 1

- (c) Find the differential equation of lines of curvature through a point on the surface
(U cos ϕ , U sin ϕ , C ϕ) 3

- (d) (i) Find the equation of tangent plane of a curve on a surface in vector form. 3

Or

- (ii) Prove that $M = 0$ is the necessary and sufficient condition for the parametric curves to have conjugate directions. 3

- (e) Find the angle that the direction (du, dv) makes with parametric curve $v = \text{constant}$. 4

- (f) (i) Find the differential equation of asymptotic line. 4

Or

- (ii) State and prove Euler's theorem. 4

3. (a) Define Minimal surface. 1

- (b) Find the equation of osculating developable of a curve

$$\vec{r} = (a \cos \theta, a \sin \theta, a \theta \cot \beta) \quad 3$$

- (c) (i) Show that surfaces $xyz = a^3$ is not developable and $xy = (Z-C)^2$ is developable. 3+3=6

Or

- (ii) Prove that equation of edge of regression rectifying developable of a space curve is

$$\vec{R} = \vec{r} + \kappa \frac{\tau \hat{t} + \kappa \hat{b}}{\kappa' \tau - \kappa \tau'} \quad 6$$

4. (a) Write the canonical equation of geodesic. 1

- (b) "An isometric map preserves _____ and _____. (Fill in the blanks) 1

- (c) Show that curvature of a geodesic at any point is the normal curvature in its direction. 2

- (d) Show that : 2

$$\kappa_g = \frac{1}{H} \left[(\vec{r}_1 \times \vec{r}_2) \times \vec{r}' \right] \cdot \vec{r}''$$

5. (a) (i) Show that torsion of a geodesic in terms of principal curvature is 3

$$\tau = \cos \psi \sin \psi (\kappa_b - \kappa_a)$$

Or

- (ii) Show that every meridian is a geodesic on the surface of revolution. 3

(u cos v, U sin v, av)

- (b) (i) Prove that the curves of the family

$\frac{v^3}{\mu^2} = \text{Constant}$ are geodesic on a surface with the metric

$$v^2 (du)^2 - 2u v du dv + 2u^2 (dv)^2 \quad 4$$

Or

- (ii) Prove that a curve on a surface is a geodesic if and only if the principal normal at every point on the curve is normal to the surface. 4

- (c) (i) State and prove Clairaut's theorem. 5

Or

- (ii) Prove that a necessary and sufficient condition that, on the general surface, the curve $u = c$ be a geodesic is that

$$GG_1 + FG_2 - 2GF_2 = 0.$$

When $u = c$ for all values of v . 5

6. (a) When a tensor A_{ij} said to be symmetric? 1

- (b) Express curl of a vector in tensor form. 2

(c) Show that δ_j^i has same component in every coordinate system. 3

(d) Show that curvature tensor R_{ijk}^a is skew-symmetric with respect to indices j and k . 4

(e) (i) Show that sum and differences of two tensors of same rank and type is again a tensor of the same rank and type. 4

Or

(ii) Show that product of two tensors is a tensor whose rank is the sum of the rank of the two tensors. 4

(f) (i) Prove that covariant derivative of the tensor g^{ij} , g_{ij} , δ_j^i all vanish identically. 6

Or

(ii) Show that fundamental tensor g_{ij} is a symmetrical tensor of order two. 6

Total No. of printed pages = 6

VI SEM PHYC 1

2023

PHYSICS (Core)

Paper : PHYC-601

(Electromagnetic Theory)

Full Marks – 50

Pass Marks – 20

Time – Two hours

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

1. Choose the correct answers : 1×5=5

(a) Mathematical expression for electromagnetic momentum density is

(i) $\mathbf{E} \times \bar{\mathbf{D}}$ (ii) $\bar{\mathbf{D}} \times \bar{\mathbf{B}}$

(iii) $\bar{\mathbf{E}} \times \bar{\mathbf{H}}$ (iv) $\bar{\mathbf{D}} \times \bar{\mathbf{H}}$

(b) Mathematical expression for electrical conductivity in ionised gases is

(i) $\frac{n_0 e^2}{m \omega}$ (ii) $\frac{n_0 e}{m \omega}$

(iii) $\frac{i n_0 e^2}{m \omega}$ (iv) $\frac{i m \omega}{n_0 e^2}$

(c) When an electromagnetic wave is reflected from a denser medium, it suffers a phase change of

- (i) $\pi/2$ radian (ii) 4π radian
(iii) 2π radian (iv) π radian

(d) When an unpolarized light is passed through a $\lambda/4$ plate, the phase difference between O-ray and E-ray will be

- (i) π (ii) $\pi/2$
(iii) 2π (iv) 0

(e) Which of the following statement is correct ?

Optically active substances are responsible for

- (i) the rotation of plane of polarization of polarized light
(ii) producing polarized light
(iii) producing bright fringes
(iv) converting ordinary light into polarised light.

2. Answer any *two* questions from the following :

$2 \times 2 = 4$

- (a) Derive the expression $\vec{\nabla} \cdot \vec{B} = 0$.
(b) Find an expression for electromagnetic angular momentum.
(c) Explain in brief how Maxwell modified Ampere's theorem.

3. (a) Prove that decrease of electromagnetic energy per unit time in a certain volume, is equal to the sum of work done per unit time by the field forces and the energy flowing outwards per unit time. 5

Or

(b) Explain Gauge transformation. Find the Gauge invariant equations for potentials of electromagnetic field. 5

4. (a) Define skin depth or penetration depth with appropriate mathematical expression. 2

(b) (i) Using Maxwell's equations, obtain the wave equation in a conducting medium. 5

Or

(ii) In case of propagating through a non-conducting isotropic medium, show that electromagnetic wave is transverse in nature. 5

5. (a) State the basic laws of reflection and refraction of electromagnetic wave at the interface between two media. 2

(b) (i) A plane electromagnetic wave is incident at the interface between two non-conducting, non-magnetic homogeneous isotropic media with its electric vector (\vec{E}) parallel to the plane of incident. Derive Fresnel's equations. 5

Or

(ii) Discuss the phenomenon of total internal reflection in case of electromagnetic medium. 5

6. (a) How is refractive index determined from Brewster's law. 2

(b) What is optic axis? How would you show the phenomenon of double refraction. 1+2=3

(c) (i) Discuss the theory of production of circularly and elliptically polarized light. 2+2=4

Or

(ii) Describe the construction and working of a Nicol Prism. 4

7. What is optical rotation? Give an outline of Fresnel's theory of optical rotation. 1+3=4

8. (a) Define phase and group velocities of guided waves. Express mathematical expressions for both the velocities. 1+1+1=3

(b) What are the boundary conditions of dielectric wave guide? 2

(c) What physical phenomenon is basically employed in wave guide operation? 1

9. (a) A step index fibre has a core index of refraction of $n_1 = 1.425$. The cut-off angle for light entering the fibre from air is found to be 8.50° . 1+1+1=3

(i) What is the Numerical Aperture (N A) of the fibre?

(ii) What is the refractive index of the cladding of this fibre?

(iii) In the fibre wave submerged in water, what would be the new NA and cut-off angle?

$$\text{[given that } \text{Lim}(8.50) = 0.798$$

$$\text{Lim}^{-1}(0.1112) = 6.38$$

refractive index of air = 1.0003

refractive index of water = 1.33]

Or

(b) What is single mode and multiple mode optical fibre? Define numerical aperture of an optical fibre. 1+1+1=3

Total No. of printed pages = 6

VI SEM PHYC 2

2023

PHYSICS (Core)

Paper : PHYC-602

(Statistical Mechanics)

Full Marks - 50

Pass Marks - 20

Time - Two hours

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

1. Choose the correct answers : 1×5=5
- (a) Entropy is
- (i) an extensive quantity
 - (ii) an intensive quantity
 - (iii) a constant quantity
 - (iv) None of these
- (b) A bosons are to be arranged in 3 cells. The total number of possible ways is
- (i) 12
 - (ii) 15
 - (iii) 81
 - (iv) 64

(c) Which of the following is fermion ?

- (i) photon (ii) Higgs boson
(iii) electron (iv) phanon

(d) Electromagnetic radiation is emitted by

- (i) all bodies at 100°C
(ii) all bodies at absolute zero
(iii) all bodies above OK at all temperatures
(iv) only a few bodies at all temperatures

(e) In which statistics, the occupation index tends to zero ?

- (i) M-B (ii) B-E
(iii) F-D (iv) None of these

2. State law of equipartition of energy. Apply it to find the specific heat of a diatomic gas.

$$1+3=4$$

3. Write short notes on any two of the following:

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

- (i) Micro Canonical Ensemble
(ii) Gibbs paradox
(iii) Boltzmann's Entropy relation
(iv) Macrostate and Microstate.

4. (a) Using the Law of equipartition of energy, show that for a perfect gas having n degrees of freedom

$$2+2=4$$

$$\gamma = \frac{2}{n} \left(\frac{n}{2} + 1 \right)$$

where γ is the ratio of molar specific heat at constant pressure to that at constant volume.

Also prove that for a diatomic gas, the ratio of the two specific heats at room temperature is 7/5.

Or

(b) A system consists of three energy levels which are non-degenerate (There is only one quantum state for each level). The energy levels are $E_1 = 0$, $E_2 = 1.4 \times 10^{-23} \text{J}$, $E_3 = 2.8 \times 10^{-23} \text{J}$.

Given that the system is at a temperature of 1K. Determine the partition function and calculate the probability that the system is in each level. (Take $K_B = 1.4 \times 10^{-23} \text{J K}^{-1}$)

$$2+2=4$$

5. (a) State Wein's displacement law. What is the wavelength at which human body radiates maximum energy ?

$$2+3=5$$

Or

- (b) Prove that the pressure of radiation is equal to the energy density and is three times the pressure of diffuse radiation. 2+3=5

6. (a) Explain the meaning of emissive power and absorptive power. 1+1=2

7. (a) Show that the average energy of Planck's oscillator of frequency f in thermal equilibrium with heat reservoir of temperature T is given by 5

$$\bar{E} = \frac{hf}{e^{hf/kT} - 1}$$

Or

- (b) A black body with an initial temperature of 600K is allowed to cool inside an evacuated enclosure surrounded by melting ice at the rate 1°C per second. If the mass, specific heat and surface area of the body are 50g, $0.1 \text{ cal g}^{-1}\text{ }^\circ\text{C}$ and 0.003 cm^2 respectively, determine the Stefan's constant. 5

8. Show that M-B distribution (Maxwell-Boltzmann) is a limiting case of B-E distribution (Bose-Einstein). 2

9. (a) State the postulates of Bose-Einstein Statistics. Derive Planck's law of black body radiation using Bose-Einstein statistics. 2+5=7

Or

- (b) Compare the similarities and dissimilarities in Bose-Einstein and Fermi-Dirac Statistics. Starting from basic assumptions, derive the relation for the occupation index. 3+4=7

$$\frac{n_i}{g_i} = \frac{1}{e^\alpha e^{E_i/KT} - 1}$$

Where the symbols have their usual meanings.

10. (a) Considering a relativistic particle (eg. electron, proton, etc.) Calculate the density of states. 4

Or

- (b) Calculate the total energy of an electron gas at absolute zero temperature for sodium containing one free electron per atom. 4

11. (a) What are White Dwarf stars? Obtain expressions for the electron density, corresponding fermi energy and fermi temperature in a typical white dwarf star.
1+2+2+2=7

Or

- (b) What is the physical meaning of Fermi Energy?

Show that the average momentum per electron at absolute zero temperature is

$$\langle P_0 \rangle = \frac{3}{4} P_F,$$

where P_F is the Fermi momentum (i.e., momentum equivalent of Fermi Energy)

2+5=7

2023

PHYSICS (DSE)

Paper : PHYD-601

(Nuclear and Particle Physics)

Full Marks – 80

Pass Marks – 32

Time – Three hours

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

1. Choose the correct answers : 1×7=7
- (a) If quark contents of Ω^- is SSS then the quark content of $\bar{\Omega}^-$ is
- (i) $\bar{u}ud$ (ii) $\bar{s}\bar{s}\bar{s}$
- (iii) $\bar{u}\bar{u}\bar{d}$ (iv) $S_R S_B S_G$
- (b) The average number of neutrons released by the fission of one uranium atom is
- (i) 2.5 (ii) 3
- (iii) 1 (iv) 2

(c) Liquid drop model predicts

- (i) depth of net nuclear potential asymmetry term.
- (ii) magic numbers, nuclear spins and nuclear particle.
- (iii) electric quadrupole moment
- (iv) accurate average masses and binding energies through semi-empirical mass formula.

(d) Isober of nucleus ${}^A_Z X_N$ is a number with

- (i) same Z but different N
- (ii) same N but different Z
- (iii) same A but different Z
- (iv) same A but different N

(e) The radiations which are not effected by electric and magnetic fields are

- (i) α -rays
- (ii) β -rays
- (iii) γ -ray
- (iv) None of these

(f) Nuclear force is not

- (i) charge symmetric
- (ii) long range
- (iii) attractive
- (iv) saturative

(g) Strangeness quantum number of Ξ^0 is

- (i) 0
- (ii) -1
- (iii) -2
- (iv) -3

2. Answer any *five* of the following : $2 \times 5 = 10$

- (a) Define binding energy. How does it vary with mass number ?
- (b) Define Parity.
- (c) Briefly explain the Gamow's theory of α -decay.
- (d) State the neutrino hypothesis.
- (e) Calculate the energy of an outgoing photon of Gamma decay.
- (f) Discuss the energy Kinematics of positive β -decay.

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

$3 \times 5 = 15$

- (a) Show that the mass density of nucleons inside a nucleus is constant throughout the volume of the nucleus. $3 \times 5 = 15$
- (b) Explain N-Z curve.

(c) State Geiger-Nuttal law and explain how the lifetime of a radioactive substance varies with energy.

(d) Write a note on Liquid-drop model.

(e) What is Gell-Mann Nisijima formula? Find the change of K^+ and Λ^0 using that formula.

(f) Calculate the isospin (I) and I_z for pions (π^+ , π^0 , π^-) using the multiplicity formula for I .

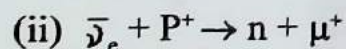
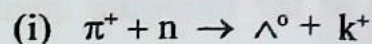
(g) Explain the nuclear reaction cross-section.

4. Answer any five of the following questions :

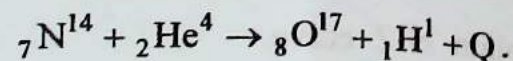
4×5=20

(a) Discuss the conservation laws of nuclear reaction.

(b) Which of the following reactions are possible according to lepton number, baryon number, strangeness number and isospin number conservation?



(c) Calculate the Q-value of the following nuclear reaction :



The atomic mass of the particles are

$$\text{N}^{14} = 14.00753 \text{ amu}$$

$$\text{He}^4 = 4.00386 \text{ amu}$$

$$\text{O}^{17} = 17.00450 \text{ amu}$$

$$\text{H}^1 = 1.00813 \text{ amu.}$$

(d) Give a brief explanation on Compton scattering.

(e) What do you mean by GM plateau? How the regulating voltage of a nuclear GM counter is determined from this plateau?

(f) With a note on Pair Production.

5. (a) What is the principle of a linear accelerator? Discuss the working theory with relevant diagram. 5

Or

(b) What is cyclotron? What are the major disadvantages of such an accelerator? 1+4=5

6. (a) Discuss the energy loss of charged particles passing through a medium. Derive the expression for specific energy loss/stopping power of a medium. 2+4=6

Or

- (b) What is relative stopping power and specific ionisation loss? Find the relation between the range and energy of charged particles.

2+4=6

7. (a) Discuss analytically the Rutherford Scattering and find the expression for Rutherford Scattering formula.

6

Or

- (b) Write short notes on:

3+3=6

- (i) Kinematics of nuclear reaction
(ii) Resonance reaction.

8. (a) Explain the Fermi gas model of nucleus.

6

Or

- (b) Explain the principle and mechanism of nuclear shell model.

6

9. (a) Write down the semi-empirical mass formula and explain the significance of each term.

5

Or

- (b) Describe the construction and working of scintillation detector.

5

Total No. of printed pages = 4

VI SEM STSC 1

2023

STATISTICS (Core)

Paper : STSC-601

(Design of Experiments)

Full Marks – 50

Pass Marks – 20

Time – Two hours

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

1. Choose the correct answer from the given alternatives in each question:

1×5=5

- (a) An experimental design is

(i) a map

(ii) a plan of experiment

(iii) a statistical diagram

(iv) All of these

[Turn over

(b) Error sum of squares in RBD as compared to CRD using the same material is

- (i) more (ii) less
(iii) equal (iv) not comparable

(c) Which parametric relations are necessary conditions for existence of a BIBD, (with usual notation)

- (i) $vr = bk, \lambda(v-1) = r(k-1), b \geq v$
(ii) $v\lambda = br, \lambda(v-1) = r(k-1), b \geq v$
(iii) $vr = bk, v(\lambda-1) = k(r-1), b < v$
(iv) $v(r-1) = b(k-1), \lambda v = rk, b < v$

(d) In a 2^4 - factorial experiment, number of first order interaction effect is

- (i) 4 (ii) 6
(iii) 2 (iv) 5

(e) If different effects are confounded in different blocks, it is said to be

- (i) complete confounding
(ii) partial confounding
(iii) balanced confounding
(iv) None of these

2. Answer the following questions in brief:

3×5=15

- (a) Define experimental error.
(b) What are the basic principles of experimental design?
(c) Define Balanced Incomplete Block Design.
(d) What are the advantages of factorial experiment?
(e) Explain orthogonality in factorial experiment?

3. (a) Describe the statistical analysis of an RBD. Compare the efficiency of an RBD with the CRD.

5+5=10

Or

(b) In an $r \times r$ LSD, what are the considerations in the choice of r ? Give the assumptions and applications of an LSD in field experimentation. Give the layout and analysis of a LSD.

1+2+7=10

4. (a) Derive two equality relations among the parameters of a BIBD.

5

Or

- (b) Show that in a symmetric BIBD, any two blocks have the same number λ of treatments in common. 5

5. (a) Explain what is meant by main effects and interactions in factorial experiment. A complete 2^3 -experiment is replicated r times in an RBD, write down the analysis procedure stating the null hypothesis. 2+8=10

Or

- (b) Give in detail the analysis of a partially confounded 2^3 -experiment. Give the expression for the standard errors of the unconfounded and the confounded effects. 8+2=10

6. (a) Describe fractional factorial experiments. 5

Or

- (b) Write a short note on one-half fraction of a 2^3 -factorial experiment. 5

2023

STATISTICS (Core)

Paper : STSC-602

(Multivariate Analysis and
Non-Parametric Methods)

Full Marks – 50

Pass Marks – 20

Time – Two hours

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

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

- (a) Let $Z = (X, Y)$ be a bivariate normal random variable. Then which of the following statement is false ?

(i) X and Y are dependent if and only if they are uncorrelated

(ii) $X + Y$ is univariate normal

[Turn over

(iii) $Y | X = x$ is distributed as a normal random variable

(iv) $X + Y$ and $X - Y$ are independent

(b) Let X_1, X_2, \dots, X_n a random sample of size 'n' from a p-variate normal distribution with mean μ and positive definite covariance Σ . Choose the correct statement.

(i) $(X_1 - \mu)' \Sigma^{-1} (X_1 - \mu)$ has χ_1^2 distribution.

(ii) $\bar{X} X'$ has Wishart distribution with p.d.f.

(iii) $\Sigma (X_1 - \mu) (X_1 - \mu)'$ has Wishart distribution with 'n' d.f

(iv) $X_1 + X_2$ and $X_1 - X_2$ are independently distributed

(c) When referring to a multivariate random variable X , then matrix Σ refers to the

(i) Correlation

(ii) Coefficient

(iii) Variance covariance

(iv) Variance correlation

(d) Consider the two statements :

(1) Principal components are orthogonal to each other

(2) The variation explained by first Principal component is maximum.

(i) (1) true (2) false

(ii) (1) false (2) true

(iii) (1) and (2) both true

(iv) (1) and (2) both false

(e) The sign test assumes that the samples are

(i) independent

(ii) dependent

(iii) have the same mean

(iv) None of these.

2. Answer the following questions in brief :

2×6=12

(a) Give the marginal probability density function of a bivariate normal distribution.

(b) State two properties of bivariate normal distribution.

- (c) Define Mean vector and Dispersion matrix.
- (d) State two properties of multiple correlation coefficient.
- (e) Distinguish between parametric and non-parametric test.
- (f) Define Kolmogrov-Smirnov test for one sample. [Almost similar to question No.-3(e)]
3. Answer any *three* questions : $5 \times 3 = 15$
- (a) Determine the conditional density of a bivariate normal distribution.
- (b) Define multivariate normal distribution. Write probability density function of multivariate normal distribution. What is the characteristic function of multivariate normal distribution ?
- (c) State and prove necessary and sufficient condition for the multivariate normal vectors to be independent.
- (d) Write a note on principal component analysis.

4. Define Coefficient of Partial correlation.

$2+6=8$

Show that :

$$R_{1.23}^2 = 1 - \frac{w}{w_{11}} = \frac{r_{12}^2 + r_{13}^2 - 2r_{12}r_{13}r_{23}}{1 - r_{23}^2}$$

5. Write short notes on any *two* of the following : $5 \times 2 = 10$

- (a) Factor Analysis
- (b) Two sample sign test
- (c) Kruskal-Wallis test.

Total No. of printed pages = 5

VI SEM STSD 1

2023

STATISTICS (DSE)

Paper : STSD-601

(Econometrics)

Full Marks – 50

Pass Marks – 20

Time – Two hours

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

1. Choose the correct alternatives : $1 \times 5 = 5$

(a) In the general linear model in usual notation, the simplest set of assumptions is

(i) $E(u) = 0$

(ii) $E(uu') = \sigma_u^2$

(iii) X has rank $k < n$

(iv) All of the above

[Turn over

(b) For a set of explanatory variables X_2 and X_3 , if the coefficient of correlation is equal to 1, this means that between X_2 and X_3 , there exists

- (i) No collinearity
- (ii) Low level of collinearity
- (iii) Perfect collinearity
- (iv) Very high collinearity

(c) When error terms across cross-section data are correlated, it is known as

- (i) Cross-correlation
- (ii) Cross-autocorrelation
- (iii) Spatial autocorrelation
- (iv) Serial autocorrelation

(d) The generalised least squares estimators are also called

- (i) OLS estimator (ii) BLU estimator
- (iii) WLS estimator (iv) ML estimator

(e) The coefficients estimated in the presence of heteroscedasticity are not

- (i) Unbiased estimator
- (ii) Consistent estimator
- (iii) Efficient estimator
- (iv) Linear estimator.

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

5×3=15

(a) In General Linear model $Y = X\beta + U$,

Show that $\hat{\beta} = (X'X)^{-1} X'Y$.

(b) Describe a method for detecting multicollinearity.

(c) Describe Durbin Watson test in detecting the presence of autocorrelation.

(d) Write in brief about autoregressive and lag model.

3. (a) Stating the assumptions of a general linear model, obtain an estimate of $\hat{\beta}$ of the vector of unknown coefficients β in matrix form. Also find the mean of β . 3+3+2=8

Or

- (b) Discuss the statement — “Econometrics is the amalgam of Economics, Mathematics and Statistics”.

What are the assumptions of classical linear model ?
4+4=8

4. (a) What is Multicollinearity ? For the model
 $Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \epsilon_i$, $i = 1, 2, \dots, n$,
discuss in detail the consequence of multicollinearity on least squares estimation of parameters.
2+6=8

Or

- (b) Explain in details the remedial measures to tackle the problem of multicollinearity. 8

5. (a) Describe the Aitken estimator and find its mean and variance. Show that it has least variance in the class of all unbiased linear estimators.
4+4=8

Or

- (b) Describe General Least Squares (GLS) method. Discuss this method considering an auto-correlative structure.
2+6=8

6. (a) Describe the consequences of the violation of the assumption of homoscedasticity. 6

Or

- (b) Describe two test for heteroscedasticity.

6

Total No. of printed pages = 4

VI SEM ZOOC 1

2023

ZOOLOGY (Core)

Paper : ZOOC - 601

(Developmental Biology)

Full Marks – 50

Pass Marks – 20

Time – Two hours

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

1. Choose the correct answers (any *five*): $1 \times 5 = 5$

(a) Male germ cells are produced in the

(i) Seminiferous tubule

(ii) Interstitial cells

(iii) Vas-deference

(iv) Prostate gland

[Turn over

(b) To dissolve egg membranes, sperm produces

- (i) Hyaluronic acid (ii) Hyaluronidase
(iii) Trypsin (iv) Lipase

(c) The fertilized egg divides by the process of

- (i) Regeneration (ii) Oogenesis
(iii) Cleavage (iv) Epiboly

(d) Placenta of human beings belong to

- (i) Epitheliochorial (ii) Syndesmochorial
(iii) Endotheliochorial (iv) Haemochorial

(e) The agent that causes abnormal development in embryo is

- (i) Neurogen (ii) Teratogen
(iii) Antigen (iv) Protozen

(f) The germ layer that produces nervous system is

- (i) Ectoderm (ii) Endoderm
(iii) Mesoderm (iv) Cortical layer

2. Write brief notes on any *two* :

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

- (a) Types of blastula
(b) Egg membranes
(c) Phases of development
(d) Differential gene expression
(e) Apoptosis.

3. Differentiate between (any *two*) :

$3 \times 2 = 6$

- (a) Growth and differentiation
(b) Alecithal egg and polylecithal egg
(c) Epimorphosis and morphallaxis
(d) Amnion and Allantois.

4. (a) Describe the various patterns of cleavage in animals. Discuss the effect of yolk in the process of cleavage.

$4 + 4 = 8$

Or

(b) Discuss the mechanism of fertilization with suitable illustration. Give a note on its significance.

$6 + 2 = 8$

5. (a) Define fate map. Describe how fate maps are constructed by natural and artificial marking.

$1 + 7 = 8$

Or

- (b) What do you understand by primary organizer ?
Describe suitable experiments to demonstrate
the organizer concept. $1+7=8$

6. (a) Discuss with diagram the various types of
placenta on the basis of distribution pattern of
chorionic villi. 7

Or

- (b) What do you understand by implantation ?
Discuss the different types of implantation in
different animals with diagram. $1+6=7$

7. (a) What are the different types of meta-
morphosis ? Give a descriptive note on the
process of metamorphosis in amphibians.
 $2+5=7$

Or

- (b) Define teratogenesis. Mention two teratogenic
agents and their effects on the development
of embryo. $1+6=7$

Total No. of printed pages = 4

VI SEM ZOOC 2

2023

ZOOLOGY (Core)

Paper : ZOOC - 602

(Evolutionary Biology)

Full Marks - 50

Pass Marks - 20

Time - Two hours

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

1. Choose the correct options : $1 \times 4 = 4$

(a) Which of the following does not belong to the
Hardy Weinberg Principle ?

(i) Frequency remained fixed through
generations

(ii) Used algebraic equations

(iii) Gene pool remains constant

(iv) Allele frequency varies from species.

- (b) Gene drift occurs when gene migration occurs
- (i) by chance (ii) spontaneously
- (iii) slowly (iv) due to disaster
- (c) How many factors affect the Hardy Weinberg principle ?
- (i) Six (ii) Four
- (iii) Seven (iv) Five
- (d) In Lamarck's view, the key of organic evolution is that each progeny
- (i) shows struggle for existence
- (ii) characters acquired by parental generation are inherited.
- (iii) is similar to its parents
- (iv) phylogeny is repeated in its ontogeny.
2. Write short answers to the following questions :
- (a) What is Genetic law ? 2
- (b) What is bottleneck phenomenon ? 2

- (c) What is the application of Hardy Weingberg equilibrium ? 3
- (d) Write the role of migration and mutation in changing allele frequencies. 3
- (e) Who gave Neo-Darwinism theory ? What are the postulations of Neo-Darwinsim ? $1+2=3$
- (f) Write about the causes and effect of mass extinctions. 3
3. What is variation ? Write about the heritable variation and their role in evolution. $1+4=5$
4. What was the first evolution of horse ? Write briefly the fossil history of horse. $1+6=7$
5. (a) What is adaptive radiation ? Illustrate it by Galapogos finches. $1+4=5$
- Or
- (b) Write a briefly note on allopatric and sympatric speciation. $2\frac{1}{2}+2\frac{1}{2}=5$
6. What are the unique hominin characteristics contrasted with Primate characteristics. 5

7. (a) What does it mean by RNA world? Write about the Neutral theory of molecular evolution. 3+5=8

Or

- (b) How photosynthesis was originated? Describe the types of fossil and their significance in evolutionary biology. 3+5=8

Total No. of printed pages = 4

VI SEM ZOOD 1

2023

ZOOLOGY (DSE)

Paper : ZOOD - 601

(Animal Behaviour And Chronobiology)

Full Marks – 50

Pass Marks – 20

Time – Two hours

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

1. Answer the following questions with appropriate responses : 1×5=5
- (a) Taxis is a _____ movement. (Fill in the blank)
- (b) Royal jelly is secreted from the _____ gland of worker bees. (Fill in the blank)
- (c) The most fascinating response to the lunar rhythms is shown by
- (i) Grunion fish (ii) Cat fish
- (iii) Salmon fish (iv) Jelly fish
- (Choose the correct answer)

(d) Melatonin level is high during _____
(Fill in the blank)

(e) Father of chronobiology is _____
(Fill in the blank)

2. Write short notes on any *five* of the following :
3×5=15

- (a) Chronotherapy
- (b) Role of melatonin in circadian rhythm
- (c) Waggle dance in honey Bee
- (d) Learnt behaviour
- (e) Pavlov's experiment
- (f) Photic and Non-photic zeitgebers.

3. Write long answers to the following questions :
6×5=30

(i) (a) What is Imprinting? Describe the Imprinting theory with the help of Lorenz's experiment.
1+5=6

Or

(b) What is Ethology? Distinguish between the proximate and ultimate causes of behaviour.
1+5=6

(ii) (a) What is Kinesis behaviour? Explain Orthokinesis and Klinokinesis behaviours in animals.
1+5=6

Or

(b) Describe the various types of individual behavioural patterns. 6

(iii) (a) Give an account of foraging behaviour in honey bee. Also state its advantages and disadvantages.
3+3=6

Or

(b) What is sexual selection? Explain intra-sexual (male rivalry) and inter-sexual (female choice) selection in animal.
1+5=6

(iv) (a) What is a biological clock? Describe its adaptive importance and relevance.
1+5=6

Or

(b) What is Chronobiology? Explain the developments in chronobiology from a historical perspective.
1+5=6

(v) (a) How do biological rhythms work? Describe the biological rhythms' short and long term effects. 1+5=6

Or

(b) Explain the concepts of 'synchronization' and 'masking' in terms of biological rhythm. 6

Total No. of printed pages = 5

VI SEM ZOOD 2

2023

ZOOLOGY (DSE)

Paper : ZOOD-602

(Wildlife Conservation and Management)

Full Marks – 50

Pass Marks – 20

Time – Two hours

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

1. Choose the correct option/Fill in the blanks of the following : 1×5=5
 - (a) In remote sensing, _____ spectroscopy (emission/ absorption) is used for analytical purposes without bringing the sample in contact with the instrument.
 - (b) The tender shoots of shrubs and trees eaten by certain herbivores is called as _____.
 - (c) The new expression that Verhulst added in the exponential equation for population growth to derive the logistic differential equation is _____.

[Turn over

(d) Quarantine for all species of Wildlife should be for a minimum of days _____.

(e) Geographical linkages between source areas, essential for gene flow are called _____.

2. (a) Write short answers to any *four* of the following five questions : $3 \times 4 = 12$

(i) What are 'welfare factors' of a wildlife habitat? Write the purpose of habitat management. $1 + 2 = 3$

(ii) Write a short note on the sources of water in a wildlife habitat. 3

(iii) Mention some steps to improve or increase the food availability for herbivores. 3

(iv) What is cover? Mention any two types of natural cover with their roles. $1 + 2 = 3$

(v) Distinguish between sample census and population estimate. Name any four indirect methods of population estimation based on counting wildlife signs on the field. $1 + 2 = 3$

(b) (i) Differentiate between local stability and global stability. What is multiple state stability? $2 + 1 = 3$

Or

(ii) Calculate the rate of change of population when $P(t) = 10, 500$ and 1000 . Given, the low-density growth rate $r = 0.4$ and a carrying capacity $K = 1000$. 3

3. (a) Write long answers to any *two* of the following questions : $5 \times 2 = 10$

(i) What do you mean by habitat degradation? Mention some physical and chemical problems found in the soils of degraded terrestrial ecosystems. Suggest measures to restore degraded habitat. $1 + 1\frac{1}{2} + 2\frac{1}{2} = 5$

(ii) Discuss the different methods for preserving genetic diversity. 5

(iii) Describe any three covers that may be introduced artificially in a habitat. How does invasive species degrade habitat of the native wildlife? $3 + 2 = 5$

- (b) (i) What is the concept of carrying capacity?
Describe a method for its estimation.

3+3=6

Or

- (ii) What are the Government's initiatives to promote ecotourism / wildlife tourism in Assam? Describe the procedure for developing a sustainable project on ecotourism.

2+4=6

- (c) What is the importance of 'Parasites' and 'Pathogens' in Wildlife management? Identify the links in the chain of infection of any common disease infecting wildlife. How will the management approach to control or to eradicate pathogens from wild animal populations? Write the term for professional care of injured and diseased animal?

$2+2\frac{1}{2}+2+\frac{1}{2}=7$

- (d) (i) Define the term 'Protected areas' used in Biodiversity Conservation. Distinguish between Conservation reserves and Community reserves. Discuss the roles of Community reserves in wildlife conservation with examples.

1+2+4=7

Or

- (ii) Write an essay on any national park of Assam stating its location, available habitat types with examples of inhabiting wildlife, conservation threats faced by it and the management interventions to resolve the same.

1+3+2+1=7