No. 10040

GENERAL KNOWLEDGE

Marks : 100

Time : 2 hours

The figures in the margin indicate full marks for the questions

Answer *any* **ten** questions

1. *(a)* Which Indian Coastal States were affected by cyclone 'Tauktae'?

(b) How did cyclone 'Tauktae' originate?

(c) Why do cyclones occur?

(d) Why are cyclones named? 2+3+3+2=10

2. *(a)* Where is Kharkiv?

(b) What is the capital of Ukraine?

(c) What is Operation Ganga?

(d) Who is the President of Ukraine? 2+2+4+2=10

3. *(a)* What are the objectives of Swachh Bharat Mission—Urban (SBM–U) 2·0?

(b) What are ODF+ and ODF++ in SBM?

(c) What does AMRUT stand for?

(d) What is the objective of AMRUT 2·0? 3+3+1+3=10

4. *(a)* What is Ayushman Bharat Digital Mission?

(b) When was it launched?

(c) What is digital health card? 4+2+4=10

5. *(a)* Will our New Education Policy, 2020 change India? If yes/no, explain.

(b) Mention two positive points on NEP, 2020.

(c) Mention two negative points on NEP, 2020.

(d) NEP, 2020 is considered as anti-democratic. Do you agree? 4+2+2+2=10

6. *(a)* What is climate change?

(b) Mention its effects.

(c) What is global warming?

(d) Who is Greta Thunberg? 4+2+3+1=10

7. *(a)* What is SMILE Scheme of the Government of India?

(b) Which Ministry has launched this scheme?

(c) Give the full form of SMILE.

(d) Who is the beneficiary of SMILE Scheme? 4+2+1+3=10

8. *(a)* What is the aim of CUET (UG)?

(b) What does CUET stand for?

(c) Who will be conducting CUET exam?

(d) Is CUET applicable for PG programme? 3+2+2+3=10

9. Describe the following within *40* words each (any *four*) : 2½×4=10

(a) Assam-Meghalaya Boundary Dispute

(b) Kisan Drones

(c) Withdrawal of AFSPA from parts of three North-East States

(d) Reason for acute economic crisis in Sri Lanka

(e) GST

10. *(a)* What is Jhum cultivation?

(b) Who practises Jhum cultivation in India?

(c) What are its adverse effects?

(d) Suggest three measures to control it. 2+2+3+3=10

11. *(a)* What is net neutrality and why is it important?

(b) Which country is now the topmost Internet user in the world?

(c) Do you believe that India is set to become the second largest Internet market soon? If so, how? 5+1+4=10

12. *(a)* What is meant by 'unemployment'?

(b) Mention two types of unemployment prevalent in rural India.

(c) Mention any two factors responsible for unemployment in India.

(d) Suggest four measures to tackle the problem of unemployment in India. 2+2+2+4=10

13. Fill in the blanks : 1×10=10

(a) Lack of insulin is the main cause of a disease called _____.

(b) The science of weight and measures is called _____.

(c) The study of phenomena at very low temperature is called _____.

(d) Dengue is a disease caused by the bite of mosquito called _____.

(e) The temperature in Celsius and Fahrenheit scales become equal at _____.

(f) Cud-chewing animals are called as _____.

(g) Diamond is the form of carbon that is _____.

(h) The middle region of the atmosphere is called _____.

(i) The green pigment in the leaves of a plant is called _____.

(j) The artificial kidney operates on the principle of _____.

14. Read the following paragraph carefully and answer the questions that follow :

One of the India's greatest scientists Dr. Chandrasekhara Venkata Raman is known for his path-breaking discovery—The Raman Effect that found a new method of scattering light in which it changes its energy too and not only direction, for which he was awarded the Nobel Prize in 1930. Another great scientist Subrahmanyan Chandrasekhar was awarded the Nobel Prize in 1983 for his doctoral work, as a Trinity College Fellow at the Cambridge on Physics behind the 'white dwarf' stars. Dr. Homi Jehangir Bhabha was the father of India's nuclear programme. He set up the Atomic Energy Commission and also spearheaded space activity at the department of Atomic Energy. Dr. Vikram Sarabhai equipped with a doctorate in Cosmic Rays from Cambridge, he set up Indian Institute of Management in Ahmedabad. First as India's Missile Man and then People's President Dr. A. P. J. Kalam influenced the country in more ways than one. Dr. Raja Ramanna was the man behind India's first nuclear test in Pokhran in 1974. India's National Science award are named after Shanti Swarup Bhatnagar because the country's top science administrator was a noted chemist and outstanding academician. The country owes to M. S. Swaminathan, who, as the architect of India's Green Revolution, made the country self-reliant in food grains.

(a) What is Raman Effect?

(b) Who was awarded the Nobel Prize for Physics in 1983?

(c) Who set up the Atomic Energy Commission?

(d) What is the area of research of Dr. Vikram Sarabhai?

(e) Who is considered as the architect of India's Green Revolution?

2+2+2+2+2=10

15. Read the following paragraph carefully and answer the questions that follow :

A young lad was passing along a lane in Banaras. He had some fruits in his hands. A number of monkeys followed him. Soon they became so bold that they snatch away the fruits. The lad began to run in fear. This only made the monkeys bolder still. They ran after the lad and were about to fall upon him. Just then the lad heard a voice. "Don't run, my boy. This only puts you in greater danger. Face the monkeys and they will stop." Looking up the lad saw a Sannyasi close by. He took heart and turn round and face the monkeys. They stopped at once. He move a few steps towards them, and they fall back. He then walked on with bold steps through the monkeys. They fell back still

more, and then went away. The lesson went deep into the lad's mind. After some years he became famous as Swami Vivekananda. He would then speak of it very often. He taught, "Be not afraid of anything. The moment you fear you are gone. It is fear that is the cause of misery in the world."

(a) Who was the young lad?

(b) Why did he run?

(c) What was the result of his running?

(d) What did the voice say?

(e) What did the lad do after hearing the voice and what was the result?

(f) What was the lesson he learnt? 1+1+2+2+2+2=10

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No. 11057

ENGLISH

Full Marks : 100

Time : 2 hours

The figures in the margin indicate full marks for the questions

1. Write an essay, in about *300* words, on any *one* of the following : 50

(a) Fifty Years of Meghalaya : A general analysis

(b) Sustaining Economic Development in Meghalaya during the COVID–19 Pandemic

(c) The Role of Social Media in the Lives of Youth Today

(d) Environmental Concerns in North-East India

2. Write a précis of the following passage in about one-third of its original length : 50

No amount of improvement and reconstruction in education will bear much fruit if your schools and colleges are undermined by indiscipline. An impartial examination makes it clear that students and teachers alike need more of the spirit of discipline. If proper education is to be given, acts of indiscipline prevalent in our educational institutions have to be checked.

Indiscipline may take the shape of group indiscipline or individual indiscipline. Group indiscipline is the worse of the two. While as individuals many of our students are as good as students elsewhere, the tendency to group indiscipline has increased over the years. Many causes have led to this group indiscipline. For various reasons under a foreign regime acts of indiscipline became frequent, often necessitated by political activities, which were launched against a foreign government. While there may have been justification for such indiscipline under different political circumstances, we feel

that there is hardly any justification for such acts of indiscipline after the attainment of independence. The democratic Constitution, which the country has adopted, permits the redressing of grievances through democratic machinery. It could be against all principles of democracy if such acts of violent and meaningless indiscipline were to continue.

The real purpose of education is to train youth to discharge the duties of citizenship properly. All other objectives are incidental. Discipline, therefore, should be the responsibility of parents, teachers, the general public and the authorities concerned. There are some positive factors promoting discipline. The Indian students' natural tendency is to be disciplined. It is only when forces act strongly on him that he is led astray. He appreciates rules and is normally inclined to abide by them. Much can be done to encourage this trend in school and college life. Personal contact between teacher and student is essential. Emphasis is also to be laid on the role of the class teacher or tutorial guide in promoting general discipline and the welfare of the pupils. Further a greater responsibility should devolve upon the students themselves in the maintenance of discipline. Nothing is more calculated to develop a proper sense of self-discipline and proper behaviour than their enforcement, not by any outside authority with any symbol of punishment but by the students themselves. They should choose their own representatives to see that proper codes of conduct are observed.

Another important method of bringing home to pupils the value of discipline is through group games. It is on the playing fields that the virtue of playing the game for its own sake and the team spirit can be inculcated. Such extracurricular activities as Boy Scouts, Girl Guides, the National Cadet Corps, Junior Red Cross and social service activities will promote a proper spirit of discipline. The building up of a truly harmonious and united form of community life should be the endeavour of all progressive educational institutions.

Discipline among students can only be promoted if there is discipline among the staff. The teacher and the educational administrator should realize that their activities are all being watched by their pupils. To what extent, therefore, both in their personal

conduct and in their general attitude to all problems concerning their country, they have to realize that there are limitations within which they must act for the best interests of education. Ultimately, it is the school or college atmosphere and the quality of the teachers there that ensure proper codes of conduct and discipline among our students.

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No. 12024

ENVIRONMENTAL SCIENCE

Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

Note : This paper has two sections—Paper I and Paper II. Answer any **FOUR** questions from each section (25×4)+(25×4)=200.

PAPER—I

1. *(a)* Define agroforestry and discuss different types of agroforestry systems. Give your views on : 'Should agroforestry be future of the agriculture system in India'. Why?

(b) Discuss the extent, distribution and uses of water resources. Suggest sustainable practices of conservation and management of water resources.

12+13=25

2. *(a)* What is pollution? Discuss briefly different types of pollutions created by human societies. Discuss and compare between Los Angeles photochemical smog (1944) and Great Smog of London (1952). Also comment on lessons these incidents communicate.

(b) Discuss the municipal solid waste (MSW) problem of Indian cities. Suggest ways for managing organic and plastic waste component in the MSW.

15+10=25

3. *(a)* Discuss the role of microorganisms in solid waste treatment, wastewater treatment and production of enzymes and alcohol.

(b) Discuss in brief the Sixth Schedule, Article 21 and Article 371A of the Indian Constitution.

12+13=25

4. *(a)* Discuss the evolution of EIA (Environmental Impact Assessment) tool in the world and in India. Give the authorities and institutions involved in granting EIA in India.

(b) Define remote sensing and types of remote sensing. What are different types of satellites used in India for remote sensing? 12+13=25

5. Discuss different types of radiations and their sources (natural and man-made). In what ways radiation is applied in cancer therapy, food preservation, mutagenic treatment of organisms for genetic improvement and alternative source of energy? 10+15=25

PAPER—II

6. *(a)* Discuss different types of energy sources. For North-East India, which is the best renewable energy source and why? Discuss the patterns of energy use in India.

(b) Describe plate tectonic theory and types of plate boundaries. Describe the evolution of Himalaya and Himalayan tectonics. 13+12=25

7. Write notes on the following : 5×5=25

(a) Value and significance of biodiversity

(b) Different silviculture systems

(c) Environmental sociology

(d) Impact of coal and limestone mining in North-East India

(e) Coral reefs and Mangroves in India

8. *(a)* Discuss the types of disasters. What are the causes of forest fires in Indian forests? Also discuss the impacts of different types of forest fires on the biodiversity.

(b) Discuss the salient points of the Disaster Management Act. Describe the disaster management cycles. 15+10=25

9. *(a)* What do you understand by sacred forests and sacred groves? Compare the traditional biodiversity conservation system of North-East India with the present protected areas like National Parks and Sanctuaries.

(b) What are biodiversity hotspots? How many hotspots are falling within India? Discuss their significance. 15+10=25

10. *(a)* Define systems of environmental accounting, economic accounting and green accounting. Discuss the differences and similarities in system of environmental-economic accounting (SEEA) and green accounting.

(b) Describe in brief the sampling techniques for air, water, soil, plant populations and animal populations. What is the difference between random sampling and stratified sampling? 15+10=25

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No. 13020

AGRICULTURE

Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

PART—I

1. Explicate the effects of environmental pollution on crops, animals and human. Discuss the effect of environmental factors on crop distribution and agricultural production. Describe the cropping pattern in different agro-climatic zones of Meghalaya. 10+10+5=25

2. Explain the soil and water conservation practices required by farmers of hilly regions. Discuss, in detail, the improved agro-techniques for upland maize cultivation with respect to time and method of sowing, spacing, seed rate, pest and nutrient management and weed control. 10+15=25

3. Discuss the advantages on marketing of agricultural and allied produces by farmers' groups rather than individually. Examine the advantages and limitations of Farmer Producer Organizations (FPOs) from farmers' perspective. Enumerate key functions of the Meghalaya Agricultural Management and Extension Training Institute (MAMETI). 10+10+5=25

4. Write short notes on the following : 5×5=25

(a) Soil solarization is a vital practice for weed control

(b) Reclamation measures for acidic soil

(c) Application of remote sensing and GIS in agriculture

(d) Contingency planning for rainfed farming

(e) Type of sprinkler irrigation system

PART—II

5. What are chromosomal aberrations? Describe the structural aberrations and their genetic significance. Discuss the role of Cytoplasmic Genetic Male Sterility (CGMS) and Self-Incompatibility (SI) systems in hybrid seed production. 5+10+10=25

6. Discuss the photosynthetic pigments in plants and the factors influencing photosynthesis. Describe the role of auxin and cytokinin in plant growth and development. Explain the mechanism of photoperiodism in short-day plants. 10+10+5=25

7. Discuss different components of integrated disease management. Describe the incidence and management of Fall Armyworm (FAW) in maize. 10+15=25

8. Write short notes on the following : 5×5=25

(a) Techniques of hi-tech horticulture

(b) Difference between breeder seed and certified seed

(c) Mode of action of organophosphate insecticide

(d) Krebs cycle

(e) National plan for supply and distribution of food grains

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No. 14004

AGRICULTURAL ENGINEERING

Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

Question No. **1** is compulsory. Answer any **7** questions from Question Nos. **2** to **10**

No electronic device is allowed.

Assume suitable data, if necessary and indicate them clearly.

1. *(a)* Discuss on the impact of climate change on soil and water conservation in the State of Meghalaya. Describe in brief about mitigation measures for soil and water conservation works in watershed management programme. 5+5=10

(b) Brief about the rainwater harvesting potential of Meghalaya. Explain about any popular water harvesting technology with its scope in the Meghalaya State. 5+5=10

(c) Discuss on the importance of mechanized agriculture in the Meghalaya. 5

2. *(a)* What are the types of lands that require drainage? Write the benefits of drainage in agriculture. 5+5=10

(b) What does watershed management imply? State the objectives of watershed management programme. 5+5=10

(c) Write the procedures to determine the priority watershed in a cluster of watersheds. 5

3. *(a)* What do you mean by aerial photography? Write the advantages and limitations of aerial photo-interpretation over satellite remote sensing. 5+5=10

(b) Discuss all the techniques of visual and digital satellite image interpretations for soil, water and land use management. 10

(c) Write a short note on the application of remote sensing and GIS in soil and water conservation. 5

4. *(a)* What is sick well? How is it different from failed well? Discuss the rehabilitation methods for recovery of sick and failed wells. 2+3+5+5=15

(b) What is micro-irrigation? List the advantages and limitations of micro-irrigation systems. Discuss the scope and potential of drip irrigation for hilly terrain of Meghalaya. 1+2+2+5=10

5. *(a)* Write the site selection criteria and discuss the structural components to be taken care of for construction of machinery and implement shed on hills of Meghalaya. 2+3=5

(b) Discuss the different types of poultry houses being used in Meghalaya. Which particular type can be popularized in rural Meghalaya with justification? 5+2+3=10

(c) Discuss in detail the importance of drainage and sanitation requirement in cattle shed and dairy farm. 5+5=10

6. *(a)* What are the different ways of cooling internal combustion engine? List the advantages and disadvantages of each. 5+2½+2½=10

(b) What are the different types of power take-off in common use? Explain their merits and demerits. What is the standard power take-off speed of a tractor? Name the various farm machines operated by the power take-off. 5+5+2+3=15

7. *(a)* How is the biogas produced and utilized? Discuss scope of biogas energy for hill agriculture. 5+5=10

(b) Write the importance of solar energy in Indian agriculture. How is solar energy harnessed for useful applications? 5+5=10

(c) Discuss the working principle of solar thermal energy in solar water heater. 5

8. *(a)* Write short notes on the following : 2×5=10

(i) Belt conveyor

(ii) Screw conveyor

(iii) Cream separation in milk

(iv) Pasteurization

(v) Spray and roller drying

(b) How do mechanical and rheological properties affect the behaviour of agricultural produces and design of equipments for post-harvest process and management? Discuss the various components of mechanical and rheological properties. 4+4=8

(c) What do you mean by homogenization? Discuss the theory of homogenization with parameters affecting the efficiency of high-pressure homogenization. 3+4=7

9. *(a)* What do you mean by visual aids? Discuss the importance of multimedia and visual aids in educating different categories of learners. 2+8=10

(b) Enlist the applications of microprocessor in data acquisition and control of different processes. Give a brief account of measurement systems for force, torque, pressure, vacuum and temperature. 5+5=10

(c) What is a halfwave rectifier? How does it work? Discuss its characteristics. 1+2+2=5

10. *(a)* How do you determine the performance of combine harvester? Discuss the different types of grain losses in combine harvester. 5+5=10

(b) Write briefly the suitability, scope and limitations of contour bund, contour trench, contour stone walls, contour ditches and contour farming emphasizing on rainfall, soil slope, soil depth and soil type. 2×5=10

(c) Write the difference between grassed waterways and diversion channel. 5

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No. 15020

CHEMISTRY

Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer **four** questions from each Section

SECTION—I

1. *(a)* Write down the time independent Schrödinger wave equation for hydrogen atom in terms of polar coordinates. Explain the various terms involved in the equation.

(b) Define Heisenberg uncertainty principle. A microscope using suitable photons is employed to locate an electron in an atom within a distance of 0·1 Å. What is the uncertainty involved in the measurement of its velocity? (Mass of the electron $= 9 \cdot 1 \times 10^{-31}$ kg and Planck's constant $= 6 \cdot 626 \times 10^{-34}$ J-s)

(c) Calculate the dipole moment and find the percentage ionic character of the HCl molecule if the observed dipole moment of the HCl molecule is 1·08 D and the bond length is 1·276 Å. (1 D $= 3 \cdot 336 \times 10^{-30}$ C-m)

(d) Draw the molecular orbital energy level diagram for CO molecule and hence explain its polarity and ligating behaviour towards a metal ion.

(e) Calculate the lattice energy of NaI from the following data :

$$Na(s) + \frac{1}{2}I_2(s) \longrightarrow NaI(s) \quad \Delta H = -287 \cdot 6 \text{ kJ/mol}$$

$$Na(s) \rightarrow Na(g) \quad \Delta H = 108 \cdot 7 \text{ kJ/mol}$$

$$Na(g) \rightarrow Na^+(g) + e^- \quad \Delta H_{IE} = 493 \cdot 8 \text{ kJ/mol}$$

$$\frac{1}{2}I_2(s) \rightarrow \frac{1}{2}I_2(g) \rightarrow 2I \quad \Delta H_{diss} = 106 \cdot 6 \text{ kJ/mol}$$

$$I(g) + e^- \rightarrow I^-(g) \quad \Delta H_{EA} = -305 \cdot 9 \text{ kJ/mol}$$

5+6+4+6+4=25

2. (a) Derive an expression for entropy change when an ideal gas is allowed to undergo a change from initial volume V_1 to a final volume V_2 under reversible and isothermal conditions.

(b) Discuss and obtain an expression that gives the effect of increase in temperature on reaction rate.

(c) State second law of thermodynamics. An athlete takes 100 g of glucose of energy equivalent to 1560 kJ. In the event, 50% of this gained energy is spent. Calculate the mass of water that must be evaporated by perspiration to avoid any extra storage of gained energy. ($\Delta H_{vap} = 44$ kJ / mol)

(d) Discuss the phase diagram of water-water vapour-ice system from the point of view of phase rule. Point out the significance of the areas, the lines and the points in the diagram. Explain the significance of triple point.

(e) Calculate the equilibrium constant at 25 °C for $H_2 + I_2 \rightarrow 2HI$. Given that the standard free energy of formation of HI is 1·30 kJ/mol and $R = 8 \cdot 314$ J $K^{-1}mol^{-1}$. 5+5+5+6+4=25

3. (a) Show that for a first-order reaction, $A \rightarrow$ products, the time required for the successive reduction in the concentration of A by a constant factor is independent of the initial concentration of A.

(b) The rate constant of a reaction is $1 \cdot 5 \times 10^7$ s^{-1} at 50 °C and $4 \cdot 5 \times 10^7$ s^{-1} at 100 °C. Evaluate the Arrhenius parameters A and E_a.

(c) A hydrogenation reaction is carried out at 500 K. If the same reaction is carried out in the presence of a catalyst at the same rate, the temperature required is 400 K. Calculate the activation energy of the reaction if the catalyst lowers the activation energy barrier by 20 kJ/mol.

(d) Explain Schottky and Frenkel defects with suitable examples. A metallic element exists as a cubic lattice. Each edge of the unit cell is 2·88 Å. The density of the metal is 7·20 g/cc. How many unit cells are there in 100 g of the metal?

(e) What are liquid crystals? Mention their characteristics? Which substances generally behave as liquid crystal? 5+5+5+5+5=25

4. (a) Calculate the e.m.f. of the electrode concentration cell $Zn\text{-}Hg(C_1) / Zn^{2+}(aq) / Zn\text{-}Hg(C_2)$ at 25 °C, if the concentration of the Zn-Hg is $C_1 = 2$ g per 100 g of mercury and $C_2 = 1$ g per 100 g of mercury.

(b) Calculate the liquid junction potential at 25 °C between two solutions of HCl having mean ionic activities of 0·01 and 0·001 respectively. The transference number of H^+ (t_+) in HCl may be taken as 0·83.

(c) Write a short note on hydrogen-oxygen fuel cell.

(d) Calculate the e.m.f. of the concentration cell consisting of zinc electrodes, one immersed in a solution of 0·01 molality and the other in a solution of 0·1 molality at 25 °C. The mean activity coefficient of the electrolyte may be assumed to be unity.

(e) Define quantum yield. A system absorbs $3 \cdot 0 \times 10^{18}$ quanta of radiation per second. When it was irradiated for 10 minutes, it was found that $3 \cdot 0 \times 10^{-3}$ mole of the reactant had reacted. What is the quantum yield of the reaction? 5+5+5+5+5=25

5. *(a)* Explain the following :

(i) $[Co(NH_3)_6]Cl_2$ is strongly paramagnetic but $[Co(NH_3)_6]Cl_3$ is diamagnetic.

(ii) $[Mn(H_2O)_6]^{2+}$ solution is pale coloured while $[MnBr_4]^{2-}$ solution has yellow-green colour.

(iii) In octahedral complexes, the d^5 system should be exceptionally stable in their high-spin states rather than low-spin states.

(b) How many isomers are possible in the following complexes?

(i) $[Co(en)_2Cl_2]^+$

(ii) $[Co(NH_3)_3Cl_3]$

(c) Discuss the nature of M—C bonding in metal carbonyls.

(d) What do you mean by lanthanide contraction? Discuss briefly the consequences of lanthanide contractions.

(e) Discuss the acidic and basic behaviours of any substance in liquid ammonia and SO_2. What are the reasons for the disadvantages of the solvent system concept? 6+5+3+5+6=25

SECTION—II

6. *(a)* Two elimination products are obtained from the following E2 reaction :

$$CH_3—CH_2—CHD—CH_2Br \xrightarrow{OH^-} (A) + (B)$$

(i) What are the elimination products (*A*) and (*B*)?

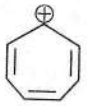
(ii) Which is formed in greater yield? Explain.

(b) Arrange the following in order of their decreasing stabilities and explain the reasons for it :

(i)  ; $(C_6H_5)_3C^-$; $(CH_3)_3C^-$; $(CH_3)_2CH^-$; CH_3^- ; $CH_3CH_2^-$

(ii) $\dot{C}H_3$; $(CH_3)_3\dot{C}$; $C_6H_5\dot{C}H_2$; $CH_3\dot{C}H_2$; $(C_6H_5)_3\dot{C}$

(c) Which, in each of the following pairs, is more stable and why?

(i)  and $C_6H_5CH_2^{\oplus}$

(ii) CH_3^- and CCl_3^-

(iii) $CH_3CH_2CH_2^{\oplus}$ and $CH_3—O—CH_2^{\oplus}$

(d) Which of the following species is aromatic?

(i) [10] Annulene

(ii) Cyclopentadiene

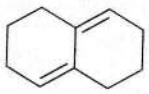
(iii) $C_9H_9^+$

(iv) $C_9H_9^-$

(e) How can you distinguish between E1 and E1cB reactions by labelling experiments?

4+6+6+4+5=25

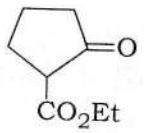
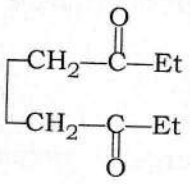
7. (a) Provide an explanation for each of the following observations in relation to the Diels-Alder reaction :

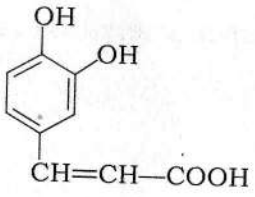
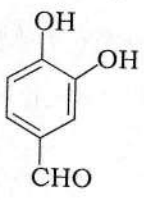
(i)  does not react as diene

(ii) When an alkyne is the dienophile, 1,4-cyclohexadiene is produced

(b) Discuss the mechanism of Cannizzaro reaction. Illustrate by choosing suitable examples, the mechanistic course of intra-molecular and crossed Cannizzaro reaction.

(c) Synthesize the following :

(i)  from 

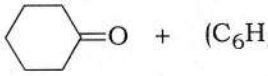
(ii)  from 

(d) Why are the nucleophillic substitution reactions of allylic halides accompanied by rearrangement?

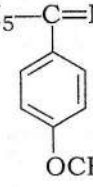
(e) Why does $LiAlH_4$ usually fail to reduce a C—C multiple bond? Why does such a bond in conjugation with an aromatic system in one side and a carbonyl group on the other side get reduced by the same reagent?

6+5+5+4+5=25

8. (a) Write the products of the following reactions :

(i)  $+ \; (C_6H_5)_3P{=}CH_2 \longrightarrow$

(ii) $BrCH_2COOC_2H_5 + C_6H_5CHO \xrightarrow{Zn}$

(iii) $C_6H_5{-}C(=N{-}OH){-}$  $\xrightarrow[H_2O]{H^+}$

(iv) $C_6H_5CH_2COCH_2Cl \xrightarrow{C_2H_5O^-}$

(v) $C_6H_5CONH_2 + Br_2 \xrightarrow{NaOH}$

(b) Make the following conversions :

(i) $C_6H_5{-}CH_3 \longrightarrow HOOC{-}C_6H_5{-}CH_3$

(ii) $CH_3CH(CH_3)CH_2CH_2OH \longrightarrow CH_3CH(CH_3)CH_2CO{-}OCH_2CH_3$

(c) Suggest a mechanism for the reaction of succinic anhydride with benzene in the presence of an aluminium chloride catalyst. Why is a minimum of two moles of the aluminium chloride catalyst required when an anhydride is the acylating agent?

15+5+5=25

9. (a) Write a step-by-step mechanism for the polymerization of vinyl chloride in the presence of an organic peroxide.

(b) Give the names and structures of the following monomers that are used to produce :

(i) Terylene

(ii) Nylon-6,6

(c) Write down the products obtained by Norrish type I and type II photochemical cleavage reactions of 2-pentanone.

(d) Discuss the mechanism of formation of hemiacetals and acetals. How is it related with the phenomenon of mutarotation?

(e) How do you account for the observation that Claisen condensation is more effective in sodium ethoxide/ether instead of sodium ethoxide/ethanol?

5+4+6+5+5=25

10. (a) Which structural features may produce a bathochromic or a hypsochromic effect in an organic compound?

(b) Biphenyl shows the following UV-absorption data. In its 2,2′-dimethyl substitution derivative, however the absorption pattern becomes almost similar to *o*-xylene. Explain :

	Biphenyl	*o*-Xylene
K-band,	$\lambda_{max} = 252$ nm, $\epsilon_{max} = 19000$	$\lambda_{max} = 262$ nm, $\epsilon_{max} = 270$

(c) Nitration of chlorobenzene gave rise to a mixture of two products *X* and *Y*. Upon reduction, *X* gave *Z* (C_6H_6NCl). The n.m.r. spectrum of *Z* revealed signals at δ 3·6 (s, 2H, disappears on shaking with D_2O), 6·6 (s, 2H) and 7·2 (d, 2H). Assign structure to *X*, *Y* and *Z*.

(d) A close look at the IR spectra of ethylacetoacetate reveals that there are strong IR absorptions at 3050 cm^{-1}, 1748 cm^{-1}, 1724 cm^{-1} and 1650 cm^{-1}. Explain the peaks observed. Give suitable explanation for the observation that ν_{O-H} band appears near 3570 cm^{-1} whereas the ν_{O-D} band near 2630 cm^{-1}.

(e) A compound *X* exhibits molecular ion at m/z 58. It exhibits a strong absorption band at ~1720 cm^{-1} in its IR spectrum and responds to iodoform test. The NMR spectrum shows only one sharp singlet at δ 2·0. Treatment of *X* with $NaBH_4$ affords another compound *Y* which shows the following spectral characteristics :

M^+ $m/z = 60$; IR = 3390 cm^{-1}; NMR = δ 1·2 (d, 6H), 3·9 (septet, 1 H) and 4·7 (s, 1 H, disappears on shaking with D_2O)

Characterize *X* and *Y* and write the equations for the reactions.

4+4+5+6+6=25

★ ★ ★

No. 16006

PHYSICS

Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer *any* **eight** questions

1. *(a)* Write the expression for the total force experienced by a moving particle in a uniformly rotating frame. Name the different terms. 13

(b) Construct the Lagrangian for a one-dimensional simple harmonic oscillator and solve the equation of motion. 12

2. *(a)* What are cyclic coordinates? Show that generalized momentum conjugate to a cyclic coordinate is conserved. 3+9=12

(b) Write the Lorentz transformation equations. Show that under Lorentz transformation length is not invariant. 8+5=13

3. *(a)* Establish an equation for damped oscillation and find its general solution. 12

(b) Find the impedance of a series *L-C-R* circuit. Calculate the a.c. current in it and find the resonance condition. 3+5+5=13

4. *(a)* Using Maxwell's equations, show that electromagnetic field propagates as a wave and velocity of this wave in vacuum is *c*, the velocity of light. 12

(b) Derive Clausius-Clapeyron equation from Maxwell's thermodynamic relations. 13

5. *(a)* Calculate the change in entropy when 10 g of ice at 0 °C is converted into steam at 100 °C (latent heat of melting is 80 cal/g and latent heat of vaporization is 540 cal/g). 12

(b) What is Joule-Thomson effect? How is this effect used in liquefaction of gases? 13

6. *(a)* Establish Schrödinger time-dependent equation. 12

(b) A proton and an electron have the same non-relativistic kinetic energy. Show that the proton has shorter de Broglie wavelength. 13

7. *(a)* If L_x, L_y and L_z are the Cartesian components of angular momentum operator, then prove that $[L_x, L_y] = i\hbar L_z$. 13

(b) If σ_x, σ_y and σ_z are Pauli's spin matrices, then prove that $\sigma_x \sigma_y = i\sigma_z$. 12

8. *(a)* Sketch an energy level diagram to show the fine structure of H_α line of Balmer series. 12

(b) Explain the spectroscopic notation of atomic states with examples. 13

9. *(a)* Sketch an energy level diagram to show the Zeeman splitting of the D_1 and D_2 lines of sodium. 12

(b) Why are anti-Stokes lines less intense than the Stokes line? 13

10. *(a)* Write the expression for semi-empirical mass formula for the nucleus and explain the meaning of various terms. 12

(b) Estimate the mass of a meson if it were the mediator of nuclear forces. 13

11. *(a)* Calculate the packing fraction of f.c.c. lattice. 12

(b) Write a short note on the response of superconductor to magnetic field. 13

12. *(a)* With the help of a neat diagram, show the different current components of a transistor. Discuss about the origin of these currents. 13

(b) Construct logic circuits using NAND gates that function as *(i)* OR gate and *(ii)* AND gate. 12

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No. 17003

MECHANICAL ENGINEERING

Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer *any* **eight** questions

1. *(a)* Two pulleys, one having 460 mm diameter and the other 180 mm diameter, are on parallel shafts 2 m apart and are connected by a crossed belt. Find the length of the belt required and the angle of contact between the belt and each pulley. What power can be transmitted by the belt when the larger pulley rotates at 200 revolutions per minute if the maximum permissible tension in the belt is 2 kN and the coefficient of friction is 0·25? 13

(b) What is the condition for correct steering? Discuss Ackerman steering mechanism. 12

2. *(a)* A metallic bar 300 mm × 100 mm × 400 mm is subjected to a force of 50 kN (tensile), 6 kN (tensile) and 4 kN (tensile) along x, y and z directions respectively. Determine the change in the volume of the bar. Take $E = 2 \times 10^5$ N/mm^2 and Poisson's ratio = 0·25. 13

(b) A hollow shaft of external diameter 120 mm transmits 300 kW power at 200 r.p.m. Determine the maximum internal diameter if the maximum stress in the shaft is not to exceed 60 N/mm^2. 12

3. *(a)* Draw iron-carbon equilibrium diagram indicating the phase temperatures. Also mention the invariant reaction. 13

(b) Explain in detail the nitriding process and its applications with a neat sketch. 12

4. *(a)* What is the function of electrolyte in ECM? Also mention the requirement of tool material for ECM. 13

(b) Explain in detail the different parameters affecting the cutting force in machining process. 12

5. *(a)* Explain the production control functions carried out in mass production with examples. 13

(b) Explain the importance of preventive maintenance and the basis of maintenance planning. 12

6. *(a)* Write a program in FORTRAN that calculates the real roots of any quadratic equation $ax^2 + bx + c = 0$ for given values of a, b and c. The program should print a message on screen if the roots are imaginary and should also be able to solve the equation if $a = 0$. 13

(b) The x and y components of a force are given by X and Y. Write a program in C language that reads X and Y, calculates the magnitude $R = \sqrt{(X^2 + Y^2)}$ and angle $\alpha = \tan^{-1}(Y/X)$ of the force. The program should be able to calculate the angle when $X \leq 0$. 12

7. *(a)* A rigid tank containing $0{\cdot}4\ m^3$ of air at 400 kPa and 30 °C is connected by a valve to a piston cylinder device with zero clearance. The mass of the piston is such that a pressure of 200 kPa is required to raise the piston. The valve is opened slightly and air is allowed to flow into the cylinder until the pressure of the tank drops to 200 kPa. During this process, heat is exchanged with the surrounding such that the entire air remains at 30 °C at all times. Determine the heat transfer for this process. 13

(b) A rigid tank with a volume of $2{\cdot}5\ m^3$ contains 15 kg of saturated liquid-vapour mixture of water at 75 °C. Now the water is slowly heated. Determine the temperature at which the liquid in the tank is completely vaporized. Also show the processes on T-v diagram with respect to saturation lines. 12

8. *(a)* Explain the fuel spray behaviour and the structure of diesel fuel. 13

(b) What are the methods by which hydrogen can be used in SI engines? Explain. 12

9. *(a)* A small sphere of reference-grade iron with a specific heat of 447 J/kg-K and a mass of 0·515 kg is suddenly immersed in a water-ice mixture. Fine thermocouple wires suspend the sphere, and the temperature is observed to change from 15 °C to 14 °C in 6·35 s. The experiment is repeated with a metallic sphere of the same diameter, but of unknown composition with a mass of 1·263 kg. If the same observed temperature change occurs in 4·59 s, what is the specific heat of the unknown material? 13

(b) A quantity of air having a volume of 300 m^3 at 30 °C dry-bulb temperature and 25 °C wet-bulb temperature is heated to 40 °C dry-bulb temperature. Estimate the amount of heat added, final relative humidity and wet-bulb temperature. The air pressure is 1·01325 bar. 12

10. *(a)* The inlet condition to a steam nozzle is 10 bar and 250 °C. The exit pressure is 2 bar. Assuming isentropic expansion and negligible inlet velocity, calculate the throat area, exit velocity and exit area of the nozzle. 12

(b) What are the various costs involved in power plant? Explain in detail. 13

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No. 18020

ZOOLOGY

Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

Candidates should attempt *any* **eight** questions

1. Distinguish between coelomate and acoelomate animals. What is canal system in sponges? With the help of suitable diagrams, explain different types of canal systems found in sponges. Leave a note on its significance. 3+3+15+4=25

2. What are endocrine glands? Name the endocrine glands found in mammalian body along with the hormones secreted by these glands. Give an account of the pituitary gland hormones with their functions. 3+6+16=25

3. What is migration? Discuss the types of migration found in birds. Give an account of the factors and guiding mechanisms in bird migration. 3+7+15=25

4. What is greenhouse effect? Name the greenhouse gases that enter the atmosphere as a result of both natural process and human activity. What are the other non-natural gases that are added due to industrial processes? Enumerate and discuss on anthropogenic causes of global warming. Suggest some suitable measures to mitigate global warming. 3+3+4+10+5=25

5. What is apiculture? What are the important criteria commonly used for selecting suitable bee species for apiculture? Name the species of honeybees commonly found in India. What kind of flora are usually preferred in and around the area for setting up an apiary? Describe the modern method of beekeeping. 2+3+4+3+13=25

6. Name the types of cell divisions found in animals. With the help of suitable diagrams, give an account of meiosis-I cell division. Write a note on the significance of meiosis. 2+18+5=25

7. Define point or gene mutation. Explain base substitution and frameshift mutations. Give a detailed account of the types of base substitution mutation. Explain how frameshift mutation is caused by the mutagen acridine dyes. 2+5+13+5=25

8. *(a)* Write an account of metamorphosis in insects and its hormonal regulation. 12

   (b) With the help of a diagram, describe the Watson-Crick model of DNA. 3+10=13

9. What is glycolysis? Write the empirical formula of glucose. With the help of a neatly drawn flowchart, describe the process of glycolysis. What is the net gain of ATP in the process? 3+1+20+1=25

10. Name the different types of muscles found in vertebrate body. Write an account on the ultrastructure of skeletal muscle with suitable diagram. Explain the mechanism of skeletal muscle contraction. 3+12+10=25

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No. 19012

COMPUTER ENGINEERING

Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

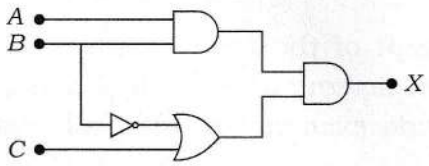
Answer *any* **ten** questions

1. *(a)* What is the difference between a context-free grammar (CFG) and a regular grammar? 4

(b) Construct a max heap for the given array of elements : 8

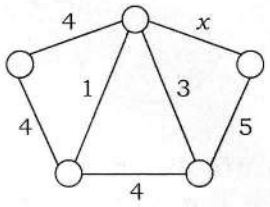
1, 5, 6, 8, 12, 14, 16

(c) Write the expression corresponding to the following logic circuit : 8



2. *(a)* What are the main phases of a compiler? 4

(b) Consider the following undirected graph G :



Choose the value of x that will maximize the number of minimum weight spanning trees of G. 8

(c) How to use the pointers to delete a node from beginning of a doubly connected linked list? 8

3. *(a)* Write a recursive procedure to compute the factorial of an integer. 4

(b) A 64 KB direct-mapped cache has 16-byte blocks. If physical addresses are 32 bits long, then how many bits are used for TAG, index and block offset in this cache? 8

(c) Consider the relation $R(A, B, C, D, E)$ with functional dependencies :

$AB \rightarrow C$

$BC \rightarrow D$

$C \rightarrow E$

What are the superkeys in this relation R? 8

4. *(a)* What is the recurrence for the worst case of quicksort and what is the time complexity in the worst case? 4

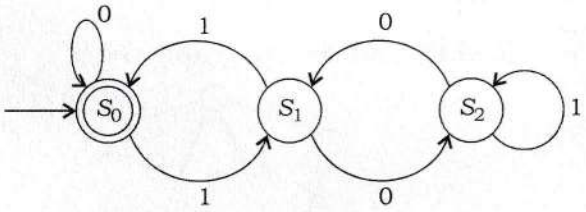
(b) Consider a disk queue with the request for I/O to blocks on cylinders. The request is in the following manner :

98 183 37 122 14 124 65 67

Considering Shortest Seek Time Fast (SSTF) scheduling, what is the total number of head movements if the disk head is initially at 53? 8

(c) Explain the concept of the Open Systems Interconnection (OSI) model. Describe its seven layers and their functions. How do they interact with each other? Provide examples of protocols used at each layer. 8

5. *(a)* The following finite automaton recognizes which language? 4



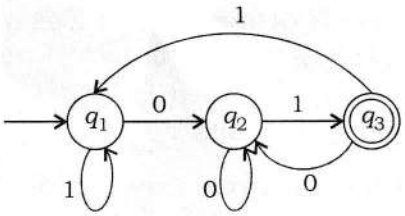
(b) What is the maximum number of subnets and the maximum number of hosts in each subnet, if the address of a class B host is to be split into subnets with a 6-bit subnet number? 8

(c) How many NOR gates are required to realize the given logical expression? 8

$$Y = (A+C)(A+D')(A+B+C')$$

6. *(a)* What is the time complexity of the merge sort algorithm and why? 4

(b) Find out the regular expression corresponding to the DFA : 8



(c) Design a sliding window protocol for packet-based data transmission of 2 Mbps where the protocol is reliable in the delivery of packets in the data link layer and transmission control protocol. The link is a point-to-point from the moon to a base station and has one-way latency or delay of 1·25 sec. The frame data used in transmission is 2 KB. Determine the minimum number of bits required for the sequence number. 8

7. *(a)* Differentiate between pre-order and post-order traversal in the binary tree. Write the procedure of each. 4

(b) Design the push-down automaton for the language $L = \{a^n b^m \mid n, m > 0, n > m\}$. 8

(c) What is the number of ways in which 5 boys and 4 girls sit around a circular table so that no 2 girls sit together? 8

8. *(a)* Show whether the relation $(x, y) \in R$, if $x \geq y$ defined on the set of positive integers, is a partial order relation. 4

(b) A 0-1 knapsack problem has four items and a knapsack capacity of 11. The weight and profit of each item are given in the below table :

P_i (in ₹)	50	30	32	27	$W = 11$
W_i (in kg)	5	6	4	3	

Which greedy strategy gives the maximum profit? 8

(c) The 2^n vertices of a graph G correspond to all subsets of a set size n, for $n > 6$. Two vertices of G are adjacent if and only if the corresponding sets intersect in exactly two elements. What is the number of vertices of degree zero in G? 8

9. *(a)* Give the equivalent prefix form of the following expression : 4

$$(p+(q-r))*((a-b)/(c-d+e))$$

(b) Prove that the relation R defined on set Z as $a\,R\,b \Leftrightarrow a-b$ is divisible by 3, is an equivalence relation. 8

(c) Consider the following relations :

BRANCH (bno, street, area, city, pcode, Tel_no, Fax_no)
STAFF (Sno, Fname, Lname, address, position, salary, bno)

Express the following queries in SQL : 8

(i) List the staffs who work in the branch at '163 main street'.

(ii) Find staffs whose salary is larger than the salary of every member of staffs at branch B3.

10. *(a)* Let X_1, X_2, X_3 and X_4 be independent normal random variables with zero mean and unit variance. What is the probability that X_4 is the smallest among the four? 4

(b) Consider that a computer on a 10 Mbps network is regulated by a token bucket. The token bucket is filled at a rate of 2 Mbps. It is initially filled to capacity with 16 megabits. What is the maximum duration for which the computer can transmit at the full 10 Mbps? 8

(c) Find the eigenvalues and eigenvectors of the following matrix : 8

$$\begin{bmatrix} 5 & 0 & 5 \\ 0 & 3 & 0 \\ 2 & 0 & -4 \end{bmatrix}$$

11. *(a)* What is a binary search tree (BST) and what are its properties? 4

(b) A box contains 3 yellow balls and 5 black balls. One by one, every ball is selected at random without replacement. What is the probability that the fourth ball selected is black? 8

(c) Discuss the process of normalization in Database Management System (DBMS). Explain the different normal forms (1NF, 2NF, 3NF) with examples, and describe the benefits of normalization in reducing data redundancy and improving data integrity. 8

12. *(a)* What is a process in an operating system, and how does it differ from a thread? 4

(b) Write an SQL query to retrieve relevant data from a university database that includes tables for students, courses, and enrollments. Your query should fulfill the following requirements : 8

(i) Retrieve the names of students who are enrolled in a specific course (e.g., "Database Systems").

(ii) Include the student's ID, name, and the course name.

(iii) Sort the results by the student's name in ascending order.

Assume the following table structures :

- Students : (StudentID, StudentName)
- Courses : (CourseID, CourseName)
- Enrollments : (StudentID, CourseID)

(c) Discuss the importance of algorithm analysis in computer science. Compare and contrast two algorithm design techniques—Divide and Conquer and Dynamic Programming. Provide examples to illustrate each technique and explain their time and space complexities. 8

13. *(a)* Explain the concept of subnetting in IP addressing. 4

(b) Explain the concept of a red-black tree. Discuss its properties. Also explain how it maintains balance during insertions and deletions, and provide a step-by-step example of inserting a series of values into a red-black tree. 8

(c) Explain De Morgan's theorems with examples and their significance in digital logic design. 8

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No. 20009

MATHEMATICS

Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

Note : (1) There are **13** questions in all, out of which **eight** are to be attempted.

(2) Question No. **1** is compulsory. Out of the remaining **12** questions, **seven** questions are to be attempted.

1. Answer any *five* questions : 5×5=25

(a) Let $T : U \to V$ be a homomorphism. Show that ker (T) is a subspace of U.

(b) State and prove mean value theorem.

(c) Find the equations of the tangent planes to the sphere $x^2 + y^2 + z^2 = 45$ parallel to the plane $2x - 4y + 5z = 0$.

(d) Find the general and singular solution of $y = px + \sqrt{a^2p^2 + b^2}$, where $p = \frac{dy}{dx}$.

(e) In an SHM of amplitude a and time period T, prove that

$$\int_0^T v^2\, dt = \frac{2\pi^2 a^2}{T}$$

(f) How high can a particle rest inside a hollow sphere of radius a, if the coefficient of friction be $\frac{1}{\sqrt{3}}$?

(g) Let $\bar{a}$, $\bar{b}$, $\bar{c}$, $\bar{d}$ be the position vectors of A, B, C, D. Show that if these four vectors lie on the same plane, then

$$[\bar{a}, \bar{b}, \bar{c}] = [\bar{b}, \bar{c}, \bar{d}] + [\bar{a}, \bar{b}, \bar{d}] + [\bar{c}, \bar{a}, \bar{d}]$$

(h) Evaluate by Green's theorem

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

where C is the rectangle with vertices (0, 0), (π, 0), (π, 1), (0, 1).

2. (a) Prove that every group of prime order is cyclic. 8

(b) If G is a group and H is a subgroup of index 2 in G, then prove that H is a normal subgroup of G. 8

(c) Let G be a group and N be a normal subgroup of G. Let f be a mapping from G to G/N defined by $f(x) = Nx \ \forall \ x \in G$. Then prove that f is a homomorphism of G onto G/N and ker $f = N$. 9

3. (a) Show that the ring of integers is a principal ideal ring. 9

(b) If D is an integral domain, then prove that the polynomial ring $D[x]$ is also an integral domain. 9

(c) Let $a \in K$ be algebraic over F. Then prove that any two minimal monic polynomials for a over F are equal. 7

4. (a) Let $S = \{1 - (-1)^n / n \mid n \in \mathbb{N}\}$. Find inf S and sup S. 8

(b) Show that a bounded sequence of real numbers has a convergent subsequence. 9

(c) Let I be a closed bounded interval and let $f : I \to \mathbb{R}$ be continuous on I. Then show that f is uniformly continuous on I. 8

5. *(a)* Consider the function h be defined as follows :

$$h(x) = \begin{cases} x+1, \text{ if } x \in [0, 1] \text{ and } x \text{ is rational} \\ 0, \text{ if } x \in [0, 1] \text{ and } x \text{ is irrational} \end{cases}$$

Show that $h(x)$ is not Riemann integrable. 8

(b) Evaluate $\lim_{n\to\infty} \frac{\sin nx}{1+nx} \; \forall \; x \in \mathbb{R}, \; x \geq 0.$ 8

(c) Show that $I = \int_0^\infty e^{-x^2} dx = \frac{\sqrt{\pi}}{2}$. 9

6. *(a)* Show that the complex function $f(z) = 2x^2 + y + i(y^2 - x)$ is not analytic at any point. 8

(b) Expand $f(z) = \frac{1}{(z-1)^2(z-3)}$ in a Laurent series valid for $0 < |z-3| < 2$. 10

(c) Evaluate $\oint_C \frac{2z+6}{z^2+4} dz$, where C is the contour given by the circle $|z-i| = 2$. 7

7. *(a)* Using graphical method, solve the following LPP : 10

Maximize $Z = 2x + 3y$

subject to the constraints

$$x + y \leq 30, \; x - y \geq 0, \; y \geq 3$$
$$0 \leq x \leq 20 \text{ and } 0 \leq y \leq 12$$

(b) Write down the dual of the following and solve it : 15

Minimize $Z = 2x_1 + 9x_2 + x_3$

subject to the constraints

$$x_1 + 4x_2 + 2x_3 \geq 5$$
$$3x_1 + x_2 + 2x_3 \geq 4$$
$$\text{and } \; x_1, \; x_2, \; x_3 \geq 0$$

8. *(a)* Find the function $f(x)$ as a polynomial in x by using the following table :

x	:	0	2	4	6	8	10
$f(x)$	:	-1	5	10	17	29	49

Hence find the value of $f(3)$. 8

(b) Given $\frac{dy}{dx} = \frac{y-x}{y+x}$ with $y = 1$ for $x = 0$. Using Euler's method, find y approximately for $x = 0 \cdot 1$ by taking $h = 0 \cdot 02$. 8

(c) Show that $\int_0^1 \frac{dx}{1+x} = \log_e 2 = 0 \cdot 69315$ by using Simpson's one-third rule dividing the range of integration into 10 equal parts. 9

9. *(a)* Deduce the trapezoidal rule for numerical integration from Gauss-Legendre quadrature formula. Also deduce the error of the trapezoidal rule. 10

(b) A solid of revolution is formed by rotating about the x-axis, the area between the x-axis, the line $x = 0$ and $x = 1$ and a curve through the points with following coordinates :

x	:	0	0·25	0·5	0·75	1
y	:	1	0·9896	0·9589	0·9089	0·8415

Find the volume of the solid of revolution. 9

(c) Derive the regula-falsi iteration formula. 6

10. *(a)* Write down the algorithm for Gauss-Seidel iterative method. 10

(b) Solve the following simultaneous differential equations by using a fourth-order Runge-Kutta method : 10

$$\frac{dy}{dx} = -x - yz$$

$$\frac{dz}{dx} = -y - xz$$

$$y(0) = 0,\ z(0) = 1 \text{ for } 0 \cdot 5 \geq x \geq 0 \cdot 0$$

(c) Express the binary number $(1011 \cdot 1101)_2$ to decimal and hexadecimal. 5

11. *(a)* Form a partial differential equation by eliminating the function ϕ from $lx + my + nz = \phi(x^2 + y^2 + z^2)$. 8

(b) Find the integral surface of the partial differential equation $(x - y)p + (y - x - z)q = z$ through the circle $z = 1$, $x^2 + y^2 = 1$. 9

(c) Solve $p + 3q = 5z + \tan(y - 3x)$, where $p = \frac{\partial z}{\partial x}$, $q = \frac{\partial z}{\partial y}$. 8

12. *(a)* Given three points (x_1, y_1), (x_2, y_2) and (x_3, y_3). Obtain a flowchart to check whether they are collinear or not. 8

(b) Write down the FORTRAN program to find one of the roots of the equation $x^3 - 3x + 1 = 0$, up to five decimal precision, using bisection method. 9

(c) In the following C statements, find the value of i : 4+4=8

(i)
```
int i, j=3, k=6;
i=j*2/3+k/4+6-j*j*j/8
```

(ii)
```
float a=1·5, b=3·0;
i=6/2·0+b*4·0/a-8·0
```

13. *(a)* Find the moment of inertia of a circular ring about a diameter. 8

(b) State and prove D'Alembert principle. 10

(c) Show that the angular momentum about the origin of a body moving in two dimensions is the moment of momentum of the centre of inertia of the body and moment of momentum relative to centre of inertia. 7

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No. 21016

FORESTRY

Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

Candidates should attempt Question Nos. **1** and **8** which are compulsory and selecting *any* **five** from each Section—A and Section—B

SECTION—A

1. Write short notes on the following in about *80* words each : 5×5=25

(a) Artificial regeneration of *Pinus kesiya*

(b) Microclimate of forest stand

(c) Joint forest management

(d) Global warming

(e) Forest genetic resources conservation

2. What are the chief objectives of artificial regeneration? Explain how artificial regeneration should be carefully planned to ensure success of the plantation. 3+12=15

3. Describe in detail the uniform shelterwood system in management of forest. 15

4. Explain with examples how mangrove forests protect a habitat against natural disasters. 15

5. Describe the phenology, regeneration and silvicultural characters of the following species : 7½×2=15

(a) *Tectona grandis*

(b) *Gmelina arborea*

6. Explain the need and scope of agroforestry with special reference to Meghalaya. 15

7. What are the watershed characteristics identified so far? Explain in detail the role of forest in preventing soil erosion and flood. 3+12=15

SECTION—B

8. Answer any *five* of the following in about *80* words each : 5×5=25

(a) Discuss briefly with examples the major forest types of North-East India according to Champion and Seth.

(b) Describe the various methods of wood—seasoning and preservation.

(c) Write short notes on ecological succession and climax of vegetation.

(d) Discuss the present status of raw materials for various wood-based industries in the State of Meghalaya.

(e) What are the important salient features of the Wildlife Protection Act, 1972?

(f) Discuss the role of women in forestry.

9. Explain in brief the concept of sustained yield and how sustained yield of forest crop can be managed to maintain a balance between environment protection and development. 15

10. What is the difference between working plan and working scheme? Discuss the broad outline of the working plan of a forest division. 5+10=15

11. What is the difference between volume table and yield table? Explain in detail the important uses of yield table. 5+10=15

12. Explain in detail how prismatic and chain survey is carried out in forest areas. 15

13. What are the five main causes of forest damage? Explain briefly the preventive and protective measures of forest. 5+10=15

14. What are the basic objectives of the National Forest Policy, 1988? Explain any four important strategies envisaged in the Policy in order to achieve the objectives. 3+12=15

★ ★ ★

No. 22002

ELECTRICAL ENGINEERING

Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer **four** questions from Group—I and **four** from Group—II

GROUP—I

1. *(a)* Two batteries *A* and *B* are connected in parallel and a load of 10 Ω is connected across their terminals. *A* has an e.m.f. of 12 V and an internal resistance of 2 Ω; *B* has an e.m.f. of 8 V and an internal resistance of 1 Ω. Use Kirchhoff's laws to determine the values and directions of the currents flowing in each of the batteries and in the external resistance. Also determine the potential difference across the external resistance. 6

(b) State the superposition theorem as applicable to an AC network. 4

(c) What is meant by resonance in a series *R-L-C* circuit? Support your answer with the help of phasor diagram. 3+3=6

(d) What is the difference between a passive filter and an active filter? Describe a simple passive low-pass filter. 3+6=9

2. *(a)* Explain the propagation characteristics of transverse electric (TE), transverse magnetic (TM) and transverse electromagnetic (TEM) waves in rectangular waveguide. 10

(b) Discuss the reflection of plane waves at the interface of conductor for the normal incidence as well as oblique incidence. 10

(c) Develop the concept of displacement current using Maxwell's equations. 5

3. *(a)* Explain the operation of a half-wave rectifier with waveforms. 7

(b) Explain the block diagram of an op-amp. 10

(c) Define biasing of BJT and explain the need for biasing. 8

4. *(a)* Explain the working of 2 : 1 Mux with a logic circuit. 10

(b) Explain *J-K* flip-flop with the help of logic diagram, truth table and timing diagram. 10

(c) List five applications of DAC. 5

5. *(a)* Why is a starter necessary for a DC motor? Explain any one type of DC shunt motor starter with a suitable diagram. 10

(b) Describe the working of three-phase transformer. Why are transformers rated in kVA and not in kW? 8+2=10

(c) State the condition for parallel operation of three-phase alternator. Name one method that is used for synchronizing alternators. 4+1=5

6. *(a)* Deduce the two-transistor model for a thyristor and explain the thyristor operation using this model. 10

(b) What is meant by modulation in communication system? Explain the benefits of modulation in a communication system. 10

(c) List five types of antenna array. 5

GROUP—II

7. *(a)* Compare open-loop and closed-loop control systems based on different aspects. 10

(b) List the characteristics of a good insulation material. 5

(c) Explain conductivity in conductors, semiconductors and insulators using band theory. 10

8. *(a)* Explain the working of a microprocessor with the help of a simplified block diagram. 10

(b) Define range, projected range and straggle with respect to ion implantation. Also explain the damage produced due to light ion and heavy ion with a neat diagram. 10

(c) What is multiprocessing? List its advantages and disadvantages. 5

9. *(a)* Describe with the help of a circuit diagram, how you will measure power in a three-phase, four-wire system. 10

(b) What is Schering bridge? Develop the equation of balance for the bridge. 10

(c) List the different types of errors in measurements. 5

10. *(a)* Using equal area criterion, derive an expression for critical clearing angle for a system. 10

(b) Develop and explain the block diagram of automatic load frequency control of an isolated power system. 10

(c) Explain the method of solving the swing equation by point-by-point method. 5

11. *(a)* Explain the different types of overcurrent protection schemes. 10

(b) What are the advantages and disadvantages of SF6 circuit breaker? 10

(c) Write a short note on solid state relay. 5

12. *(a)* Explain the principle and application of wind electric systems. State the basic components and their working in wind electric systems. 15

(b) What is solar insolation? 5

(c) List five differences between pulse-code modulation and delta modulation. 5

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No. 23001

CHEMICAL ENGINEERING

Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

PAPER—I

(*Marks* : 100)

Answer *any* **four** questions

1. *(a)* Starting from the parabolic velocity profile of the one-dimensional (axial) fully developed steady, incompressible, laminar flow of a viscous fluid (viscosity : μ) in a circular pipe of radius R, derive the expressions for the average velocity and maximum velocity across the cross-section of the pipe, and the volumetric flow rate. Assume the pressure drop over a length of pipe L to be Δp. 12

(b) For the flow described in part *(a)*, determine the radial distance from the centreline where the actual velocity is equal to the average velocity. 8

(c) If the radius of the circular pipe in part *(a)* is 2 cm, and if the velocity profile is given by $u(r) = 2(1 - r^2 / R^2)$ in m/s, determine the numerical value of the maximum velocity and the volumetric flow rate. 5

2. *(a)* Describe the operation of an orifice meter, with diagram, for measuring fluid flow. 5

(b) What is Fanning friction factor? How is it related to the Reynolds number for laminar flow through a circular pipe? Calculate the Fanning friction factor for the turbulent flow of water through a smooth circular pipe of diameter 0·2 m at an average velocity of 0·2 m/s. Take $\mu_{water} = 1 \times 10^{-3}$ Pa-s and $\rho_{water} = 10^3$ kg/m^3. 10

(c) Explain the operation of a roll crusher. 5

(d) What is minimum fluidization velocity? How can Ergun equation be used to determine the minimum fluidization velocity? 5

3. It is desired to distill a feed of fifty percent saturated vapour containing 30% *n*-pentane and 70% *n*-heptane. The vapour-liquid equilibrium data for this system is given below :

x (*n*-pentane)	0·0	0·059	0·145	0·254	0·398	0·594	0·867	1·000
y (*n*-pentane)	0·0	0·271	0·521	0·701	0·836	0·925	0·984	1·000

The overhead should contain 95 mol% *n*-pentane and the bottoms 10 mol% *n*-pentane; the reflux ratio should be 1·3 times the minimum. Using the McCabe-Thiele method, calculate the number of ideal stages required and the ideal stage on which the feed should be added. 25

4. Answer the following questions : 5×5=25

(a) Describe the penetration theory of mass transfer.

(b) Discuss the type of packing used in packed-bed gas-absorption columns.

(c) Define relative volatility. What is the significance of relative volatility in separation by distillation?

(d) Discuss the important factors for the selection of solvent for liquid-liquid extraction.

(e) Explain the working principle of a rotary drier with a sketch.

5. Water is used to cool lubricating oil in a double-pipe heat exchanger. The oil flows on the tube side at a rate of 0·5 kg/s, entering and leaving the heat exchanger at 380 K and 350 K respectively. The overall heat transfer coefficient may be taken as 250 W/(m^2-K).

(a) Using the LMTD method, determine the required heat transfer area for both counter-current operations, if water is flowing on the shell side at 0·20 kg/s and enters the heat exchanger at 280 K. 10

(b) Using the NTU method, calculate the effectiveness, the NTU and required heat transfer area for parallel-flow (co-current) operations, if water is flowing on the shell side at 0·25 kg/s instead and enters the heat exchanger at 285 K. 15

6. Answer the following questions : 5×5=25

(a) Discuss the supports commonly used for process vessels.

(b) Describe the design equations for calculating the thickness of cylindrical shell.

(c) Explain the design procedure for flat head and elliptical head.

(d) Describe the working of a Bourdon tube pressure gauge. How does backlash introduce error in pressure gauge reading?

(e) What is a thermocouple? What is its working principle? State the typical composition of a type K thermocouple.

7. *(a)* A process is described by the transfer function

$$G_1(s) = \frac{3e^{-2s}}{(1-s)(3s+1)}$$

Calculate the response $y(t)$ to a step change in input $u(t)$ of magnitude 2. 5

(b) The following transfer function describes a process :

$$G(s) = \frac{K}{(\tau s + 1)(s + 1)}$$

For a proportional-integral controller, find the range of controller settings that yield stable closed-loop systems. Does the integral mode tend to stabilize or destabilize the system relative to proportional-only control? Give reasons to support your answer. 15

(c) Consider the frequency response to a sinusoidal forcing function. Find the amplitude ratio (AR) and phase angle (ϕ) for the following transfer function at $\omega = 1$ rad/min, if time constants have units of minutes : 5

$$\frac{25(s+1)}{s(5s+1)(s+5)}$$

PAPER—II

(*Marks* : 100)

Answer *any* **four** questions

8. One hundred gram moles of CO at 300 °C is completely burned with 50% excess air which is at 100 °C (assume that air has $N_2 : O_2$ ratio of 79 : 21). The exit gases leave at 400 °C. What is the heat transfer to or from the system in kJ? Assume ideal gas behaviour wherever needed. The standard heat of formation (at 25 °C) of CO is −110·52 kJ/mol. The temperature dependence of the specific heat capacity is given by the equation

$$C_p = a + bT + cT^2 + dT^3 \quad (C_p \text{ in J/(mol-K) and } T \text{ in K})$$

The values of the parameters for the gases are as follows :

	a	b	c	d
CO	28·95	$0{\cdot}411\times10^{-2}$	$0{\cdot}3548\times10^{-5}$	$-2{\cdot}22\times10^{-9}$
N_2	29·00	$0{\cdot}2199\times10^{-2}$	$0{\cdot}5723\times10^{-5}$	$-2{\cdot}871\times10^{-9}$
O_2	29·10	$1{\cdot}158\times10^{-2}$	$-0{\cdot}6076\times10^{-5}$	$1{\cdot}311\times10^{-9}$

25

9. *(a)* One mole of an ideal gas, $C_p = 3{\cdot}5R$ and $C_v = 2{\cdot}5R$, is compressed adiabatically in a piston-cylinder device from 2 bar and 298·15 K (25 °C) to 8 bar. The process is irreversible and requires 35% more work than a reversible, adiabatic compression from the same initial state to the same final pressure. What is the entropy change of the gas?

[*Note* : R is the universal gas constant.] 15

(b) The freezer of a household refrigerator is to be maintained at –15 °C when the surrounding temperature is 30 °C. If the coefficient of performance (COP) is 50% of a Carnot refrigerator operating between the same two temperature levels, determine the amount of cooling produced (in watt) per watt of electricity consumed. 5

(c) Write the Clausius and Kelvin-Planck statements of the second law of thermodynamics. 5

10. *(a)* Calculate the fugacity and fugacity coefficient of liquid cyclopentane at 110 °C and 250 bar. At 110 °C, the vapour pressure of cyclopentane is 5·267 bar and the fugacity coefficient of the saturated vapour is 0·90. The molar mass of cyclopentane is 70·13 g/mol and the specific volume of saturated liquid cyclopentane at 110 °C is 1·522 cm^3/g. Assume liquid volume to be independent of pressure. 10

(b) Consider the vapour-liquid equilibrium of a binary mixture at 50 °C. If the mole fraction of component 1 in the liquid phase is 0·40, determine the vapour phase composition using modified Raoult's law (assuming vapour phase to be ideal). The activity coefficients at infinite dilution are $\gamma_1^\infty = 2{\cdot}5$ and $\gamma_2^\infty = 2{\cdot}2$. The activity coefficients (γ_i) are given by

$$\ln\gamma_1 = x_2^2[A_2 + 2x_1(A_1 - A_2)]; \quad \ln\gamma_2 = x_1^2[A_1 + 2x_2(A_2 - A_1)]$$

where A_i are constants. The saturation vapour pressures are given by

$$\log_{10} P^{sat} = A - B/(T + C) \quad (P^{sat} \text{ in bar and } T \text{ in K})$$

	A	B	C
Component 1	4·23	1246	–55·2
Component 2	5·25	1599	–46·4

15

11. *(a)* Briefly discuss the production of coke from coal in a coke oven plant including a flow diagram showing different sections of the plant along with short description of the important sections. In addition to coke, what other products are typically obtained from carbonization of coal? 10

(b) Describe catalytic reforming in petroleum refining briefly. Discuss the most prevalent main reactions in catalytic reforming. 10

(c) Explain hydrocracking during petroleum refining briefly. 5

12. *(a)* Discuss the operation of cyclone separator and wet scrubber for air pollution control. What are the respective advantages and disadvantages? 10

(b) Name two common types of catalysts along with specific examples used in the production of polyolefins. What are the differences among LDPE, HDPE and LLDPE in terms of structure, physical properties and production conditions? 5

(c) Describe the measurement of total suspended particulate matter using high-volume sampler. 5

(d) What is the Forest (Conservation) Act, 1980? What is the penalty for contravention of the provisions of the Act? 5

13. Answer the following questions : 5×5=25

(a) The initial installed cost of an equipment is ₹ 5,00,000 and the useful life period is 7 years. At the end of 7 years, the equipment has no salvage value. Using the double declining balance method of depreciation, calculate the allowable depreciation (in ₹) for the second year.

(b) What does PERT stand for? Discuss the technique briefly.

(c) What are the typical direct and indirect costs that constitute the fixed capital investment of a chemical process?

(d) What is HAZOP analysis? Explain briefly the main advantages and limitations.

(e) An annual cash flow of ₹ 1,00,000 is received at the end of each year for 10 years. The rate of interest will be 8 percent per year compounded annually. Determine the net present value at time zero (start of the project).

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No. 24001

STATISTICS

Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer *any* **five** questions

1. *(a)* Distinguish between a discrete and a continuous random variable. Define a distribution function of a random variable and show that it is monotonic non-decreasing everywhere and continuous on the right at every point. Let X be a random variable whose range space is $R : \{X : 0 \le x \le 2\}$ and $f(x) = kx$. Show that $f(x)$ is a p.d.f. 4+6+2=12

(b) Given a function of continuous random variable X as $f(x) = kx(1 - x)$, with range space $R : \{X : 0 \le x \le 1\}$. Is $f(x)$ a density function? If so, find $P(A_1)$, where $A_1 = \{X : 0 \le x \le 1/3\}$ and $P(A_2)$, where $A_2 = \{X : x \ge 2\}$. 8

(c) Define conditional expectation and conditional variance of random variables. For the jointly distributed random variables X and Y, show that

$$V(X) = E[V(X|Y)] + V[E(Y|X)]$$ 4+4=8

(d) Define the moment of a random variable. Find the first four moments of a random variable X, where

$$p(x) = \frac{e^{-\lambda}\lambda^x}{x!}, \quad x = 0, 1, 2, \cdots; \lambda > 0$$

Comment on the shape of the distribution of X. 2+8+2=12

2. *(a)* Define consistency of an estimator. Show that the proportion of successes in a series of n trials with constant probability of success p for each trial, is a consistent estimator of the population proportion of success P. 2+6=8

(b) Define efficient estimator. State and prove Rao-Blackwell theorem related to sufficient statistic and minimum variance estimator. 2+10=12

(c) State and prove Neyman-Pearson lemma for testing a simple hypothesis against a simple alternative. 8

(d) What is meant by test of significance? What is likelihood ratio test and its properties? Derive the likelihood ratio test statistic for testing mean of normal population. 2+4+6=12

3. *(a)* Consider the Gauss-Markov linear model $y = A\beta + \varepsilon$, with all the regular assumptions. If $\lambda'\beta$ is estimable, then prove that its best estimate is $\lambda'\hat{\beta}$, where $\hat{\beta}$ is any solution of the equation $A'A\beta = A'y$. 10

(b) Describe the test procedure for testing significance of regression, in a multiple linear regression, of the response y on the regressor variables $x_1, x_2, \ldots, x_k$. 10

(c) Let $\underline{X}_1, \underline{X}_2, \cdots, \underline{X}_n$ be a random sample from an $N_p(\underline{\mu}, \Sigma)$ population. Show that the Hotelling's T^2 statistic for testing $H_0 : \underline{\mu} = \underline{\mu}_0$ vs. $H_0 : \underline{\mu} \neq \underline{\mu}_0$ is a generalization of the square of the t-statistic for testing $H_0 : \mu = \mu_0$ vs. $H_0 : \mu \neq \mu_0$ in the univariate case. 10

(d) Give the formal mathematical definition of the ith pair of canonical variables and corresponding canonical correlation, for $i = 1, 2, \cdots, k$, in terms of the standard notations involving the variance-covariance matrix Σ. Provide the necessary details, without proofs, for obtaining the canonical variables and their correlations. 10

4. *(a)* In every kth systematic sample of size n, obtain the appropriate expression for $V(\bar{y}_{sys})$ in terms of the population variance S^2 and the intraclass correlation coefficient ρ_w, and show that a positive correlation between units in the same sample inflates the variance of the sample mean. 10

(b) In two-stage sampling, show that if n units are selected by SRSWOR from N primary units and from each primary unit, if m units are selected from M secondary units again by SRSWOR, then the estimate of the variance of the unbiased estimator $\bar{\bar{y}}$ of $\bar{\bar{Y}}$ is given by

$$v(\bar{\bar{y}}) = (1-f_1)\frac{s_b^2}{n} + f_1(1-f_2)\frac{s_w^2}{nm}$$

(The notations have their usual meanings) 12

(c) Explain the basic principles of design of experiment. Examine how far these principles are met within the Latin Square Design. Give the skeleton analysis of variance table for the Latin Square Design. 8

(d) Show that in 2^3-experiment, the main effects and interactions are mutually orthogonal. Suppose you wish to set up an experiment to test the effectiveness of 2 levels of nitrogen, 2 of phosphate and 2 of potash on the yield of potatoes and have enough land to plant 40 plots. Show how you will set up this experiment. How you will analyze the results obtained? 10

5. *(a)* What do you mean by Statistical Quality Control (SQC)? Discuss its need and utility. Distinguish between process control and product control. Discuss the situations in which they are used. 10

(b) Explain the basis and working of a control chart to control the fraction defective when the number of articles inspected varies. State the important steps involved while establishing the control limits for future production giving the practical way of overcoming the difficulties that arise due to varying inspection number. 5+5=10

(c) Describe the method of Double Sampling Plan and derive its OC, AOQ, ATI and ATI curves. 20

6. *(a)* What do you mean by assignment problem? How do you interpret it as a linear programming problem (LPP)? If the completion time (in hour) of different jobs by different workers is as given in the following table, determine the optimal assignment of jobs to the workers : 3+2+5=10

		Jobs				
		A	*B*	*C*	*D*	*E*
Workers	*I*	5	11	10	12	4
	II	2	5	6	3	5
	III	3	12	5	14	6
	IV	6	14	4	11	7
	V	7	9	8	12	5

(b) Explain two-person zero-sum game by suitable example. Determine which of the following two-person zero-sum games are strictly determinable and fair. Give optimum strategies for each player in the case of strictly determinable games : 4+6=10

(i)

	Player B	
Player A	5	0
	0	2

(ii)

	Player B	
Player A	0	2
	−1	4

(c) Explain the two-phase method for solving a given LPP. Use two-phase simplex method to

Maximize $Z = 5x_1 + 3x_2$

subject to

$$2x_1 + x_2 \leq 1$$
$$x_1 + 4x_2 \geq 6$$
$$x_1, x_2 \geq 0$$

4+4=8

(d) For $(M|M|1) : (\infty \mid \text{FIFO})$ queue system, derive the steady-state distribution of the queue length. 12

7. *(a)* Explain time series model and its components. 10

(b) Define stationary time series process and autocovariance function. Show that autocovariance function, denoted by $\gamma(h)$, is an even function, positive semi-definite and uniformly continuous if it is continuous at $h = 0$. 10

(c) Explain the steps in the construction of a consumer price index number and discuss a method of its construction. 10

(d) Explain the problem of heteroscedasticity. Discuss one method of detecting it. What happens to OLS estimators if we introduce heteroscedasticity? 10

8. *(a)* Differentiate among Total Fertility Rate (TFR), Gross Reproduction Rate (GRR) and Net Reproduction Rate (NRR). How does NRR indicate the growth of the population? 10

(b) Describe the logistic curve, generally used for the projection of a human population at a time t. Describe some of its properties. 10

(c) Discuss stable population theory. What are the consequences of this to the population? How is stationary population connected to stable population? 10

(d) What do you understand by a T-scale? Explain clearly the method of converting raw test scores into T-scores. Show that this scaling procedure helps in the process of normalizing a skew distribution. 10

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No. 25001

HORTICULTURE

Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

PAPER—I

SECTION—A

(*Marks* : 25)

1. For the establishment of orchard, what are the criteria needed for—

(a) site selection;

(b) system of planting;

(c) layout of orchard? 9+8+8=25

SECTION—B

(*Marks* : 25)

2. *(a)* What is meant by stock-scion relationship? 9

(b) What are the causes and remedies of graft incompatibility? 8+8=16

SECTION—C

(*Marks* : 25)

3. Write short notes on the following : 9+8+8=25

(a) Alternate bearing in fruits

(b) Fruit cracking

(c) High density planting in fruits

SECTION—D

(*Marks* : 25)

4. Describe in detail the effect of climate on vegetable and tuber crop production. 25

PAPER—II

SECTION—A

(*Marks* : 25)

5. *(a)* Describe in detail the principles involved in garden design. 12

(b) What do you understand by protected cultivation? 5

(c) What are the scope and problems of protected cultivation in India? 8

SECTION—B

(*Marks* : 25)

6. *(a)* What is meant by post-harvest losses? 9

(b) What are the causes and prevention of post-harvest losses? 8+8=16

SECTION—C

(*Marks* : 25)

7. Write short notes on the following : 13+12=25

(a) Role of village agricultural cooperative societies

(b) Concept of national income

SECTION—D

(*Marks* : 25)

8. *(a)* What is afforestation? 5

(b) Describe the regeneration methods of forest tree species. 10

(c) What are the causes and effects of deforestation? 10

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No. 26002

ELECTRONICS ENGINEERING

Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer *any* **eight** out of **ten** questions

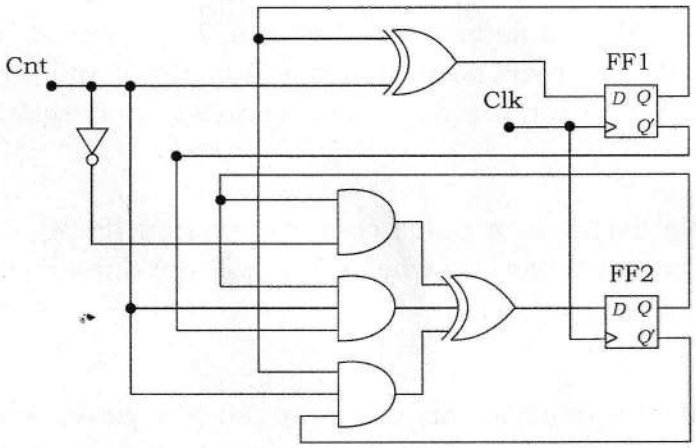
1. *(a)* Convert the following function into canonical product of sum (CPOS) form and then simplify it using K-map : 7

$$F(A, B, C) = A\overline{B} + B\overline{C} + \overline{A}\overline{B}\overline{C}$$

(b) Implement the following function using multiplexer : 8

$$G(A, B, C, D) = \Pi(3, 10, 12, 13, 14)$$

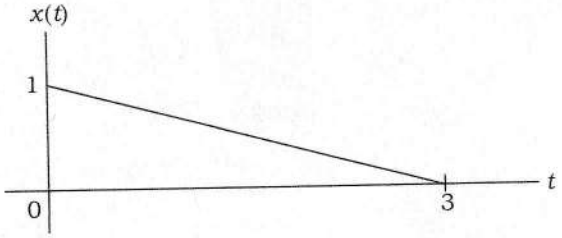
(c) Derive the state table and state diagram for the sequential circuit given below : 10



(Here : Cnt = Count, Clk = Clock and FF stands for Flip-Flop)

2. *(a)* If $x(t) = 5 + 2\sin(4\pi)t$ and $y(t) = 6\cos(6\pi)t + 4\sin(2\pi)t$, then find $z(t)$, where $z(t) = x(t) * y(t)$, and $*$ is convolution. 8

(b) A signal $x(t)$ is represented in the following figure. Find out $x(t) * x(t)$: 7



(c) The response $y[n]$ of an LTI system for input $x[n]$ is presented using a first-order difference equation as follows :

$$y[n] - ay[n-1] = x[n]$$

If the system is in initial rest condition, find the value of a for which the system is stable. 10

3. *(a)* The following equation gives a frequency-modulated voltage wave :

$$E = 12\cos(6 \times 10^8 t + 5\sin 1250t)$$

Find the *(i)* carrier frequency, *(ii)* signal frequency, *(iii)* modulation index, *(iv)* maximum frequency deviation and *(v)* power dissipated by the FM wave in a 10-ohm resistor. 10

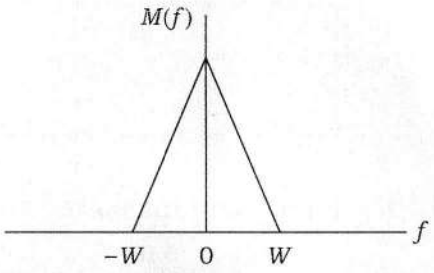
(b) A 2-bit PCM modulator is used with a 0–1 V signal. What is the binary digital value that will occur for the inputs 0·4 V and 0·78 V? Calculate the quantization error for these two samples and explain with a labelled diagram. 10

(c) The code length in a pulse code modulation (PCM) system is increased from 6 bits to 8 bits. By what factor will the quantization noise power be increased or decreased? 5

4. *(a)* Calculate the modulation index for an FM wave, where the maximum frequency deviation is 50 kHz and the modulating frequency is 5 kHz. 5

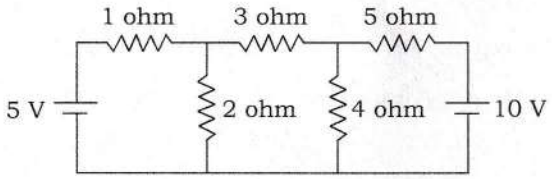
(b) Implement the function $F1 = \overline{X}Y\overline{Z} + X\overline{Y}Z$ using NAND gate. 5

(c) Consider a message signal $m(t)$ with the spectrum $M(f)$ shown in the figure below :

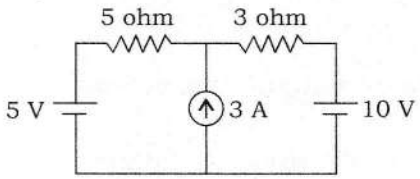


The message bandwidth $W = 1$ kHz. This signal is applied to a product modulator, together with a carrier wave $A_c \cos(2\pi f_c t)$, producing the DSB-SC modulated signal $s(t)$. Next, the modulated signal is applied to a coherent detector. Assuming perfect synchronism between the carrier waves in the modulator and detector, determine the spectrum of the detector output when *(i)* the carrier frequency $f_c = 1{\cdot}25$ kHz and *(ii)* the carrier frequency $f_c = 0{\cdot}75$ kHz. What is the lowest carrier frequency for which each component of the modulated signal $s(t)$ is uniquely determined by $m(t)$? 15

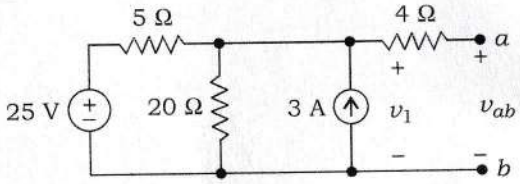
5. (a) Find the value of the currents $I1$, $I2$ and $I3$ flowing clockwise in the first, second and third mesh respectively : 10



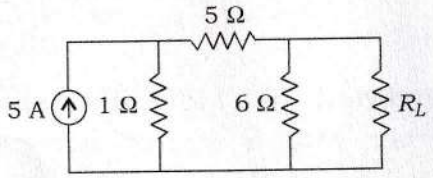
(b) Calculate the mesh currents $I1$ and $I2$ flowing in the first and second mesh respectively : 5



(c) Find the Thevenin's equivalent circuit for the following circuit : 5



(d) Find the value of R_L for maximum power transfer : 5



6. (a) Explain tunnel diode with a diagram. 5

(b) What are built-in electric field and drift velocity? Briefly explain the relation between these two. 5

(c) Explain mass action law and diffusion current. Also, explain Einstein's equation in this context. 5

(d) The hole concentration in *P*-type semiconductor is given by $P = 10^{12}\left(5 - \frac{x}{10^{-3}}\right)/\text{cm}^3$, for $0 < x < 10^{-3}$ cm. Find out the hole diffusion current at $x = 6\,\mu\text{m}$, where $D_P = 20\,\text{cm}^2/\text{s}$, and assume that the sample is cylindrical with a cross-sectional area of $1{\cdot}25 \times 10^{-4}$ cm^2. 10

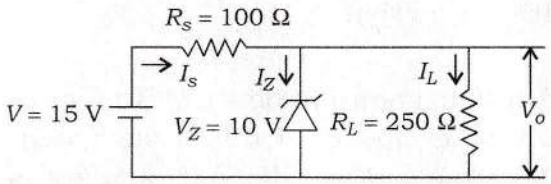
7. (a) Discuss four Maxwell equations in electromagnetic field for both differential and integral forms. What is the physical significance of them? 7

(b) Explain briefly the lossless and distortionless transmission line with example. 4

(c) Define antenna radiation pattern, cut-off frequency, gain and directivity. 4

(d) Briefly explain the TE and TM modes of electromagnetic propagation. Write down and explain the rectangular waveguide with example. 10

8. *(a)* A Zener diode shunt regulated power supply is depicted in the figure below :



Determine the *(i)* output voltage, *(ii)* source current and *(iii)* current through the Zener diode. Assume that the Zener resistance is equal to zero. 5

(b) A voltage-series feedback amplifier has $A = -100$, $R_i = 25\ \text{k}\Omega$, $R_o = 10\ \text{k}\Omega$ and feedback factor $\beta = -0 \cdot 1$.

(i) Determine the overall gain, input impedance and output impedance of the feedback amplifier.

(ii) If the gain has been reduced to –2·5, what will be the feedback factor?

In this circuit, A is the gain of the main amplifier, R_i is the input resistance and R_o is the output resistance. 5

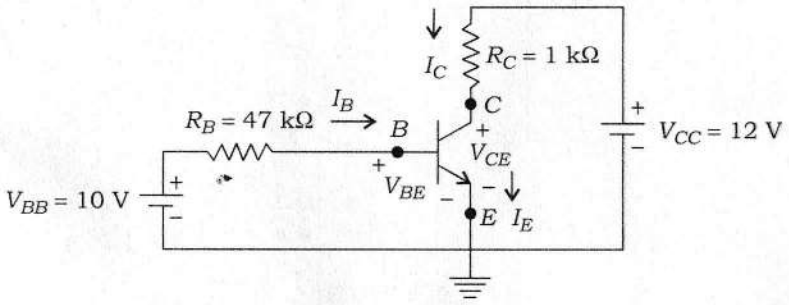
(c) The input base currents of differential amplifiers are $I_{B1} = 100\ \text{nA}$ and $I_{B2} = 80\ \text{nA}$.

(i) Determine the input bias current and the input offset current.

(ii) When $A = 10^5$, calculate the output offset voltage.

Assume $R_s = 1\ \text{k}\Omega$. In this circuit, A is the gain of the main amplifier; I_{B1} and I_{B2} are the two input currents and R_s is the source resistance. 5

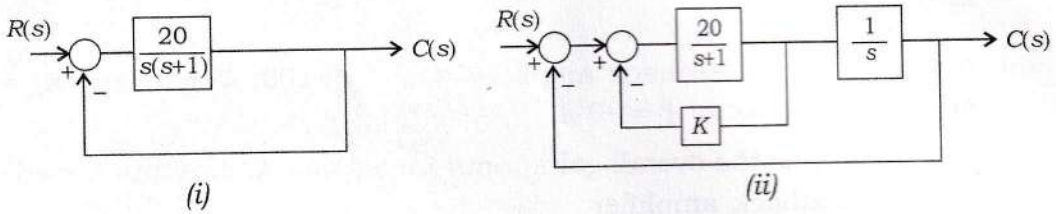
(d) A transistor amplifier circuit is shown in the figure below :



Draw the DC load line and locate the Q-point on the DC load line. Assume $V_{BE} = 0 \cdot 7\ \text{V}$ and $\beta = 50$; β is the current gain. 10

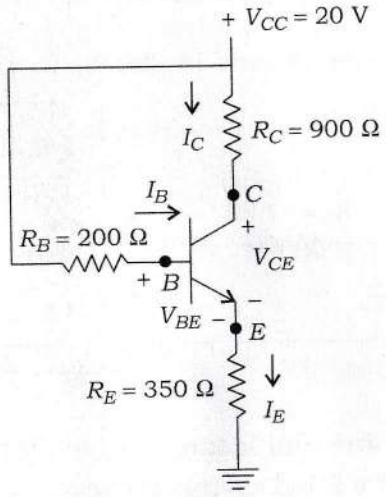
9. *(a)* Find the stability of the system $G(s) = \dfrac{K}{s(s+1)}$ and $H(s) = 1$ using the Routh-Hurwitz stability criterion. 5

(b) Consider the system shown in figure *(i)*. To improve the performance of the system, feedback is added to this system, which results in figure *(ii)*. Determine the value of K so that the damping ratio of the new system is 0·4. Compare the overshoot, rise time, peak time, settling time and the nominal value of the systems shown in figures *(i)* and *(ii)* : 10



(c) Draw the root locus of the feedback system whose open-loop transfer function is given by $G(s)H(s) = \dfrac{K}{s(s+1)}$. 10

10. *(a)* The figure below shows the fixed bias with the emitter feedback circuit. Determine the base current, collector current, collector-to-emitter voltage and stability factor of the biasing circuit. Assume $V_{BE} = 0 \cdot 7$ V and $\beta = 50$; β is the current gain : 10



(b) Convert the equation $Y(s) = \frac{2s}{(s+1)(s+2)}$ into time domain. 5

(c) Determine the initial value of the time-domain response of the equation $Y(s) = \frac{2s+1}{(s+1+j)(s+1-j)}$ using the initial value theorem. Determine the initial value of the time-domain response of the equation $Y(s) = \frac{2s}{(s+1)^2(s+2)}$ using the initial value theorem. 10

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No. 27004

COMPUTER APPLICATION/COMPUTER SCIENCE

Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer all the questions as directed.

GROUP—A

(C Programming and Data Structures)

Answer *any* **five** questions

1. *(a)* In what way can **? :** operator be used in place of an if-else? 4

(b) Write a C program to generate the Fibonacci series (1,1,2,3,5,8,13,...). 6

2. *(a)* What is the purpose of the do-while statement? How does it differ from the while statement? 3

(b) What is Recursion? Write a recursive function to find the factorial of a number. 2+5=7

3. What is sorting? Write a C program to sort an array of integers using Bubble Sort. 3+7=10

4. Distinguish between a Stack and a Queue data structure. Explain the use of a stack in the evaluation of a postfix expression. 4+6=10

5. Write a C program to insert a node at the end of a circular linked list. 10

6. Explain the working principle of the following algorithms : 5+5=10

(a) Merge Sort

(b) Radix Sort

GROUP—B

(Visual Programming using Visual Basic and VB.Net and CONM)

Answer *any* **five** questions

7. What is inheritance? Explain the use of the "MyBase" and "MyClass" keywords with appropriate examples. 3+7=10

8. What is an Exception? How can an Exception be handled? Write the code using *Try....End Try* to handle an Exception for the error "Dividing a number by zero". 1+3+6=10

9. *(a)* Differentiate between the two types of Procedures in VB.Net with a proper example. 5

(b) What do you understand by the term MDI? 5

10. Solve the following set of equations using the Gauss-Seidel procedure : 10

$$9x_1 + 2x_2 + 4x_3 = 20$$
$$x_1 + 10x_2 + 4x_3 = 6$$
$$2x_1 - 4x_2 + 10x_3 = -15$$

11. Explain the concept of interpolation. Construct the difference table and compute $f(21)$ by Newton's backward formula of the following table : 2+8=10

x	0	5	10	15	20
$f(x)$	1·0	1·6	3·8	8·2	15·4

12. *(a)* Multiply the following floating point numbers : 2+2=4

(i) 0.1111E51 and 0.4444E50

(ii) 0.1234E49 and 0.1111E54

Indicate if the result is overflow or underflow.

(b) An approximate value of π is given by 3.1428571 and its true value is 3.145926. Find absolute and relative errors. 2+2=4

(c) Round off the following numbers to four significant figures : ½×4=2

(i) 3.92542

(ii) 0.98735

(iii) 40.358

(iv) 0.005842

GROUP—C

(Computer Organization and Architecture and Software Engineering)

Answer *any* **five** questions

13. Draw the schematic diagram of a master-slave *S-R* flip-flop and discuss its working principle. 10

14. What is a mod-5 counter and how is it built? How is a decade counter realized using the mod-5 counter? 6+4=10

15. (a) Convert the following numbers from the given base to the bases indicated : 2½×2=5

(i) $(37.2)_{10} = (?)_2$

(ii) $(476.27)_8 = (?)_{16}$

(b) How many 128×8 RAM chips are needed to provide a capacity of 2048 bytes? How many lines of the address bus must be used to access 2048 bytes of memory? 2½×2=5

16. What are meant by Cohesion and Coupling in modular programming? 5+5=10

17. Explain the prototyping model for software development, highlighting its advantages and disadvantages. 10

18. Explain the key features of the Evolutionary Model of Software Process Modelling. 10

GROUP—D

(Database Management System and Data Communication and Networks)

Answer *any* **five** questions

19. Consider the universal relation $R = \{A, B, C, D, E, F, G, H, I, J\}$ and the set of functional dependencies

$$F = \{\{A, B\} \rightarrow \{C\}, \{A\} \rightarrow \{D, E\}, \{B\} \rightarrow \{F\}, \{F\} \rightarrow \{G, H\}, \{D\} \rightarrow \{I, J\}\}$$

Identify the candidate key and decompose R into 2NF and then 3NF relations. 4+3+3=10

20. Consider the following relations for a database that keeps track of automobile sales in a car dealership (OPTION refers to some optional equipment installed on an automobile) :

CAR(Serial_no, Model, Manufacturer, Price)
OPTION(Serial_no, Option_name, Price)
SALE(Salesperson_id, Serial_no, Date, Sale_price)
SALESPERSON(Salesperson_id, Name, Phone)

Specify the following queries in SQL on the above schema :

(a) For the salesperson named 'Mr. X', list the following information for all the cars she sold : Serial_no, Manufacturer, Sale_price. 5

(b) List the Serial_no and Model of cars that have no options. 5

21. Explain mirroring and stripping as used in RAID technology. 5+5=10

22. Distinguish between Message Switching and Packet Switching. 5+5=10

23. What are Load Shedding and Jitter Control? Compare Broadcast routing and Multicast routing. 5+5=10

24. Write a short note on wireless TCP and UDP. 5+5=10

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No. 28007

GEOLOGY

Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

Question No. **1** and Question No. **6** are compulsory and choose *any* **four** from Group—A and Group—B.

GROUP—A

1. Write explanatory notes on any *four* of the following : 7½×4=30

(a) Intensity and magnitude of earthquake

(b) Types of mechanical weathering

(c) Components of global positioning system

(d) Stress and strain ellipsoid

(e) Gondwana flora

(f) Chronostratigraphy

(g) Genetic classification of water

2. Define geomorphology. Discuss the geomorphic cycle proposed by Davis. Describe various types of drainage patterns. 5+15+15=35

3. Define fold. Describe the various parts of a fold. Discuss Ramsay's classification of folds. 5+10+20=35

4. Define fossils. Describe the modes of preservation of fossils. Discuss the application of microfossils for various studies. 5+15+15=35

5. Write notes on any *five* of the following : 7×5=35

(a) Basal and intraformational conglomerates

(b) Classification of aquifers

(c) Geological investigations for tunnels

(d) Shillong group of rocks

(e) Tertiary rock sequence of NE India

(f) Tectonic framework of NE India

(g) Cretaceous and tertiary boundary

GROUP—B

6. Write explanatory notes on any *four* of the following : 7½×4=30

(a) Petrological microscope and accessories

(b) Optical properties of common rock forming minerals

(c) Petrogenetic significance of the igneous textures

(d) Sedimentary facies

(e) Environment of deposition of sedimentary rocks

(f) Methods of exploration in mining geology

(g) Classification of common types of natural hazards

7. Discuss metallogenic epochs and provinces. Describe ore, gangue and tenor of ore. List the lead and zinc ore minerals. 15+15+5=35

8. Discuss the elementary thermodynamics. Describe the structure and composition of earth. 15+20=35

9. Discuss the structural classification of silicates. Describe the petrography of granites and gabbro. 15+10+10=35

10. *(a)* Discuss the geophysical methods for mineral exploration.

(b) Write the petroleum deposits of NE India. 20+15=35

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No. 29013

BOTANY

Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer **eight** questions, taking **four** from each Group

GROUP—A

1. Write notes on any *two* of the following : 12½×2=25

(a) Role of microbes in food industry

(b) Mycoplasma

(c) Transduction

(d) Defense mechanism against infection

2. Give illustrated accounts of the following : 12½×2=25

(a) Evolution of sex in algae

(b) Evolution of sporophyte in bryophyte

3. Write notes on any *two* of the following : 12½×2=25

(a) Megasporophyll of *Cycas*

(b) Inflorescence of *Gnetum*

(c) Salient features of Cycadofilicales

(d) Development of female gametophyte in *Pinus*

4. Answer/Write notes on any *two* of the following : 12½×2=25

(a) Distinguishing features of the families Malvaceae and Verbenaceae

(b) Distinguishing features of the families Orchidaceae and Poaceae

(c) Xylem and Phloem

(d) What is rule of priority and ICBN?

5. Write notes on any *two* of the following : 12½×2=25

(a) Types of endosperms in angiosperms

(b) Development of dicotyledonous embryo

(c) Stomata and their types

(d) Anomalous secondary growth in *Dracaena*

6. Answer the following : 12½×2=25

(a) Give an account on the centres of origin of cultivated plants.

(b) Define botanical gardens and herbaria and mention their importance.

7. Mention the names of five plants each having following economic importance. Also mention the family these belong to : 5×5=25

(a) Fodder

(b) Gums and Resins

(c) Fibres

(d) Timbers

(e) Spices

8. What do you understand by the term 'totipotency' ? Describe the significance of the phenomenon in plant biotechnology. 25

GROUP—B

9. Describe the structure and functions of chloroplast. 15+10=25

10. Write notes on any *two* of the following : 12½×2=25

(a) Polytene and Lampbrush chromosomes

(b) Difference between prokaryotic and eukaryotic cells

(c) Chromatin and Nucleosome

(d) Numerical and structural variations in chromosomes and their significance

11. Answer/Write notes on any *two* of the following : 12½×2=25

(a) Student's *t*-test

(b) Define multiple alleles with examples.

(c) Distinguish between back-cross and test-cross.

(d) Role of RNA in origin and evolution.

12. What are sex chromosomes? Give an account of different types of chromosomal sex determination in plants with examples. 25

13. What do you understand by the term 'genetic engineering'? Describe the role of genetic engineering in crop improvement. 25

14. Answer/Write notes on any *two* of the following : 12½×2=25

(a) Electron transport chain and Oxidative phosphorylation

(b) What are phytohormones? Discuss the physiological effects of IAA.

(c) What are enzymes? Give a brief account of enzyme action.

(d) Criteria of essentiality of nutrients

15. What do you understand by the term 'photosynthetic unit'? Enumerate the differences in C_3, C_4 and CAM mechanisms of photosynthesis. 25

16. Write notes on the following : 5×5=25

(a) Carbon cycle

(b) Biodiversity and its significance

(c) Endangered plants and Red Data Book

(d) Global warming

(e) Intellectual Property Rights

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No. 30005

CIVIL ENGINEERING

Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

PART—I

Answer *any* **five** questions

Assume suitable data, if necessary, with proper justification

1. *(a)* Classify different systems of force with suitable examples. State and prove parallelogram law of forces. 10

(b) A system of connected flexible cable shown in Fig. 1 is supporting two vertical forces 200 N and 250 N at points *B* and *D*. Determine the forces in various segments of the cable : 10

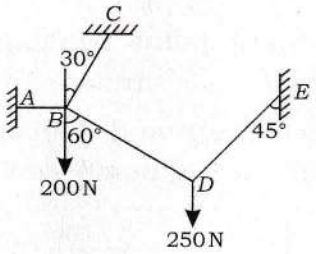

Fig. 1

2. *(a)* What are the various failure criteria of dams? Briefly explain. 10

(b) A trapezoidal masonry dam is of 20 m height. The dam is having water up to a depth of 16 m on its vertical side. The top and bottom widths of the dam are 3 m and 9 m respectively. The density of the masonry is given as 19·62 kN/m^3. Determine the maximum and minimum stress intensities at the base. 10

3. *(a)* What are the types of failure occurring in riveted joint? Briefly explain. 10

(b) A double-riveted, double-cover butt joint is used to connect plates 12 mm thick. Using Unwin's formula, determine the diameter of rivet, rivet value, gauge and efficiency of joint. Adopt the following stresses : 10

Working stress in shear in power driven rivets = 100 N/mm^2 (MPa)
Working stress in bearing in power driven rivets = 300 N/mm^2 (MPa)
Working stress in axial tension in plates = 0·6 fy

4. *(a)* Name the common types of foundation. Briefly explain their uses. 10

(b) A rectangular column 400 mm × 600 mm carries a live load of 2000 kN. The safe bearing capacity of the soil is 150 kN/sq. m. Using M-20 concrete and Fe-415 steel, design a rectangular footing to support the column. Adopt limit state design method. 10

5. *(a)* Differentiate between centrifugal pump and reciprocating pump. Briefly explain their application. 10

(b) A double-acting reciprocating pump running at 40 r.p.m. is discharging 1·0 m^3/minute. The pump has a stroke of 400 mm. The diameter of the piston is 200 mm. The delivery and suction heads are 20 m and 5 m respectively. Find the slip of the pump and the power required to drive the pump. 10

6. *(a)* Who gave the earth pressure theory first? Explain the theory. 10

(b) A retaining wall 6 m high, with vertical back, supports a cohesive backfill having a unit weight 1·9 g/cc, apparent cohesion = 0·25 kg/sq. cm and angle of internal friction zero. Calculate the *(i)* lateral pressure intensity at the top of the wall, *(ii)* depth of tension cracks and *(iii)* lateral pressure intensity at the base. 10

7. *(a)* List out the assumptions made for plastic analysis. What are the different types of mechanism? 10

(b) Find the fully plastic moment required for the frame shown in Fig. 2 if all the members have same value of M_P : 10

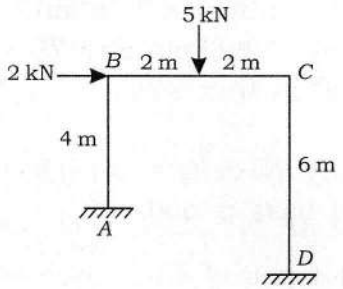

Fig. 2

PART—II

Answer *any* **five** questions

Assume suitable data, if necessary, with proper justification

8. *(a)* Name the various tests of cement. Explain in brief. 10

(b) Draw the flow diagrams for mixing of raw materials by dry process and wet process for the manufacture of ordinary cement. 10

9. *(a)* Explain in detail the classification of surveying. 10

(b) At what stations do you suspect local attraction? Find the correct bearings of lines and also compute the included angles : 10

Line	*Fore Bearing*	*Back Bearing*
AB	66°20′	246°20′
BC	139°30′	318°50′
CD	189°40′	11°20′
DA	300°30′	119°30′

10. *(a)* What are the controlling factors for highway alignments? Describe in detail. 10

(b) Calculate the stopping sight distance for design speed of 90·0 kmph. Reaction time = 2·5 s and coefficient of friction = 0·31. 10

11. *(a)* Define hydrology. Explain 'hydrological cycle' and its components with neat sketch. 10

(b) The normal annual rainfalls at stations *A*, *B*, *C* and *D* in a basin are 80·97 cm, 67·59 cm, 76·28 cm and 92·01 cm respectively. In the year 1985, station *D* was inoperative and stations *A*, *B* and *C* recorded annual precipitation of 91·11 cm, 72·23 cm and 79·89 cm respectively. Estimate the rainfall at station *D* in that year. 10

12. *(a)* Explain the terms *(i)* duty, *(ii)* delta and *(iii)* base period. Derive the relation among duty, delta and base period. 10

(b) What are the different types of cross-drainage work that are necessary on a canal alignment? State briefly the conditions under which each one is used. 10

13. *(a)* What are the components of water supply system? Outline the various sources of water. 10

(b) Identify the daily water demand of the city in 2031 if the water demand is 135 LPCD and the city population record is as given below : 10

Census Year	1950	1965	1980	1995	2010
Population	25000	52000	94000	164000	247000

14. *(a)* Distinguish between separate sewerage system and combined sewerage system. 10

(b) Design sedimentation tank for waterworks which supplies 1·6 MLD water to a town. The sedimentation period is 4 hr. The velocity of flow is 0·15 m/min and the depth of water in the tank is 4 m. Assume an allowance for sludge as 80 cm. Also find the overflow rate. 10

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