041/2025

PART – II

Total Number of Questions : 38	Maximum Marks : 200	Time : 3 Hours

INSTRUCTIONS (നിർദ്ദേശങ്ങൾ)

1. Question cum Answer Booklets are processed by electronic means. The following instructions are to be strictly followed to avoid invalidation of answer scripts.
(ചോദ്യവും ഉത്തരവും അടങ്ങുന്ന ഈ ബുക്ക് ലെറ്റുകൾ ഇലക്ട്രോണിക് സാങ്കേതിക വിദ്യയുടെ സഹായത്തോടുകൂടെ മൂല്യനിർണ്ണയം നടത്തുന്നതിനാൽ ഇവ അസാധുവാകാതിരിക്കുവാൻ താഴെപ്പറയുന്ന നിർദ്ദേശങ്ങൾ പൂർണ്ണമായും പാലിക്കുക.)

2. The first page of this question cum Answer Booklet is an OMR data Sheet (Part I). All entries in the OMR sheet are to be made with blue or black ball point pen only.
(ഈ പുസ്തകത്തിന്റെ ഒന്നാമത്തെ പേജ് ഒരു ഒ.എം.ആർ. ഡാറ്റാ ഷീറ്റാണ് (പാർട്ട് I). ഇത് നീലയോ, കറുപ്പോ നിറത്തിലെ ബോൾ പോയിന്റ് പേന ഉപയോഗിച്ച് മാത്രമേ പൂരിപ്പിക്കാവൂ.)

3. Make sure that register number is bubbled correctly and completely; no correction is permitted.
(രജിസ്റ്റർ നമ്പർ രേഖപ്പെടുത്തുന്നതിനുള്ള കുമിളകൾ കൃത്യമായും പൂർണ്ണമായും കറുപ്പിച്ചിട്ടുണ്ടെന്ന് ഉറപ്പു വരുത്തുക. തിരുത്തലുകൾ അനുവദനീയമല്ല.)

4. Do not tamper the bar code printed on the OMR sheet and subsequent pages. Tampering of bar code will result in the invalidation of this booklet.
(ഈ പുസ്തകത്തിൽ എവിടെയും പ്രിന്റ് ചെയ്തിരിക്കുന്ന ബാർ കോഡിൽ ഒരു കാരണവശാലും തിരുത്തലുകളോ, മാർക്കുകളോ പാടില്ല. ഇതിനു വിരുദ്ധമായി ചെയ്യുന്ന പക്ഷം ഈ പുസ്തകം അസാധുവാകുന്നതാണ്.)

5. Answers should be written with blue or black ball point pen only.
(ഉത്തരങ്ങൾ നീലയോ, കറുപ്പോ നിറത്തിലെ ബോൾ പോയിന്റ് പേന ഉപയോഗിച്ച് മാത്രമേ എഴുതാവൂ.)

6. Do not write anything outside the margin of space provided for writing the answer and write only one line of answer between two lines.
(പുസ്തകത്തിൽ ഉത്തരം എഴുതുവാൻ നൽകിയിരിക്കുന്ന സ്ഥലത്തിനു വെളിയിൽ യാതൊന്നും തന്നെ എഴുതുവാൻ പാടില്ല. രണ്ടു വരകൾക്കിടയിൽ ഒരു വരി ഉത്തരം മാത്രമേ എഴുതുവാൻ പാടുള്ളൂ.)

7. Rough work should be done only in the specific page provided with.
(റഫ് വർക്കുകൾ ഇതിനായി നൽകിയിരിക്കുന്ന പേജിൽ മാത്രമേ ചെയ്യുവാൻ പാടുള്ളൂ.)

1. A uniform circular lamina has mass 100 g and radius 100 cm. A circular portion of radius 2 cm centred about a point located at a distance 4 cm from the centre O of the lamina is removed from it. Find the moment of inertia of the remaining portion of the lamina about an axis perpendicular to its plane and passing through O. (6 Marks)

2. A particle, initially at rest, is moving in a constant force field F along the direction of the force. Calculate the changes in the kinetic and potential energies of particle when its displacement from the initial position is S. (6 Marks)

3. A particle of mass m_1 collides with a second particle, of mass m_2, at rest. After the collision, the particles move in opposite directions, the second particle moving with twice the speed of the first particle. Find the ratio of the masses of the particles, assuming that the collision is elastic. (6 Marks)

4. A particle is moving in a central force filed $F(r) = F(r)\hat{r}$, where r is its position vector with respect to the centre of force O and $\hat{r}$ is the unit vector along r. Show that its orbital angular momentum about O is conserved and explain why the motion of the particle is restricted to the plane perpendicular the angular momentum. (6 Marks)

5. (a) Write down the three properties to be satisfied by a well-behaved wave function.

   (b) Briefly explain the condition for a wave function to be normalised.

   (c) When can you say that two wave functions are orthogonal within some given interval? (6 Marks)

6. (a) Write down the expression for a normalised wave function in one dimension, for a particle in a box of width L.

   (b) Find the probability that a particle in a box of width L can be found between $x = 0$ and $x = L/n$, when it is in the n^{th} quantum state. (6 Marks)

7. (a) From where the energy comes when a liquid rises in a capillary tube against gravity.

   (b) The excess pressure inside a soap bubble of radius 10 cm is balanced by 0.01 cm of liquid column. Determine the density of the liquid. Surface tension of soap solution is 0.03 N/m. Take acceleration due to gravity as 10 m/s^2. (6 Marks)

8. (a) What do you mean by Modulus of elasticity?

   (b) A wire 1 m long and 1 sq cm in cross section is found to stretch 0.1 cm under a tension of 1000 kg. Compute the Young's modulus of the material of the wire. Take acceleration due to gravity as 10 m/s^2. (6 Marks)

9. Apply $(\partial Q/\partial V)_T = T(\partial P/\partial T_V)$ of thermodynamics to radiation to see that radiation-energy density is directly proportional to the fourth power of the absolute temperature T. Q is the amount of heat, V the volume and P pressure. (4 Marks)

10. Obtain the expression for efficiency of carnot engine in terms of source and sink temperatures, respectively T_1 and T_2 and discuss how it leads to second law of thermodynamics. (4 Marks)

11. One mole of ideal gas expends isothermally at temperature T. If V_1 and V_2 are the initial and final volumes, obtain the expression for work done by the gas. Calculate the value of work in joules if the expansion is at 27°C to a pressure one-tenth the original. Gas constant R = 8.3 in SI system. (6 Marks)

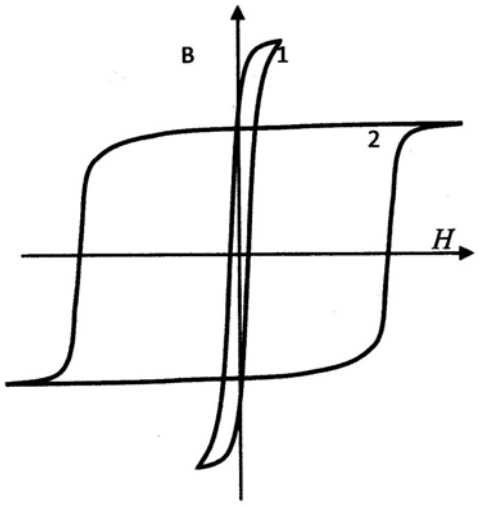
12. Starting from the equation for the instantaneous charge on the capacitor when it is charged through an inductor and resistor connected in series, show that for oscillatory charging, the angular frequency of the circuit is $(1/LC - R^2/4L^2)^{1/2}$. L is the inductance, C the capacitance and R resistance. (6 Marks)

13. Theoretically establish the existence of electromagentic wave that propagates through vacuum at the speed 3×10^8 m/s (6 Marks)

14. The Hall coefficient of certain semiconductor specimen is -5×10^{-5} m^3 C^{-1} from – 173°C to 127°C. Determine the nature of the semiconductor and identify the charge carriers and give reason. If the electrical conductivity of the specimen is 160 Ω^{-1} m^{-1}, find the density and mobility of the charge carriers. (4 Marks)

15. Plot all represented by the Miller indices <110> in cubic lattice. (6 Marks)

16. Compare and justify your inferences of the two curves given. (6 Marks)



17. Explain how a shunt capacitor filter reduces ripple in a rectifier circuit and why its effectiveness depends on load resistance. (4 Marks)

18. Explain how an emitter resistor (R_E) stabilises the Q-point against temperature variations in a CE amplifier. (6 Marks)

19. What will happen if the common-emitter (CE) amplifier used in an RC phase shift oscillator designed for a particular frequency is replaced with a common-collector (CC) amplifier? (6 Marks)

20. Using the 2's complement, subtract 10101_2 from 11010_2. (4 Marks)

21. What is EPROM and EEPROM? Why is EEPROM considered more versatile in modern applications? (4 Marks)

22. Write an assembly language program in 8085 for adding two 8-bit numbers stored in memory locations and storing the 8-bit sum in another memory location. (4 Marks)

23. Find the decimal and binary equivalents of the hexadecimal number, $2D7_{16}$? (5 Marks)

24. Simplify the following Boolean expression and draw the logic circuits for the simplified expression : $y = ABC + A\overline{B}C + AB\overline{C}$. (5 Marks)

25. A transducer provides 9 identical readings, followed by tenth reading that is 20 units lower. What is the standard deviation of the data set? (4 Marks)

26. What is the equation of the line that best approximates the relationship between the x and y values in the given data set. (6 Marks)

x :	0.04	0.15	0.3	1.0	2.0
y :	3	16	13	70	90

27. A voltmeter with 5000 Ω coil at 15°C and a temperature coefficient of 0.004/°C is used to measure 200 V. What is the percentage error in the reading at 40°C. (6 Marks)

28. Assess the potential stability of a newly discovered element with atomic number Z = 130. (4 Marks)

29. Critically evaluate the assumptions of the Bohr-Wheeler fission model and discuss its limitations in accounting for asymmetric fission fragment distributions. (6 Marks)

30. How is radon gas (atomic number Z = 86) generated, released into the environment and detected and what explains its increased levels in the air before an earthquake? (6 Marks)

31. Explain the structure of the Sun, highlighting its different layers and their characteristics. Discuss the role of sunspots, solar flares and coronal mass ejections (CMEs) in solar activity and analyse their impact on Earth's magnetosphere and technological systems. (5 Marks)

32. Describe the temperature and pressure variations across different layers of Earth's atmosphere. Discuss how the scale height affects atmospheric density and explain the role of ionospheric electric fields in radio communication and satellite navigation systems. (5 Marks)

33. Explain the characteristics of lasers and obtain Einstein coefficients. Discuss the working principle of a semiconductor laser and its applications in modern communication systems. (6 Marks)

34. Explain the working principle of optical fiber communication and discuss the advantages of fiber optic communication over traditional cable-based systems. Discuss the role of numerical aperture in light propagation through an optical fiber and justify the choice of single-mode fibres for long-distance communication. (6 Marks)

35. How the material choice and device structure influence the spectral distribution and efficiency of an LED. Support your answer with an example. (4 Marks)

36. Compare and contrast PIN photodiodes and Avalanche photodiodes (APDs) in terms of structure, responsivity and applications in optical communication. (4 Marks)

37. Explain with suitable examples how dimensionality affects the physical and electronic properties of nanostructures. (5 Marks)

38. Compare Top-Down and Bottom-Up nanofabrication techniques with respect to scalability, precision and cost. Provide an application example of each. (5 Marks)