Self Assessment Paper

1

General Instructions :

(1) *All questions are compulsory. There are 33 questions in all.*

(2) *This question paper has five sections : Section A, Section B, Section C, Section D and Section E.*

(3) *Section A contains ten very short answer questions and four assertion reasoning MCQ's of 1 mark each, Section B has two case based questions of 4 marks each, Section C contains nine short answer questions of 2 marks each, Section D contains five short answer questions of 3 marks each and Section E contains three long answer questions of 5 marks each.*

(4) *There is no overall choice. However internal choice is provided. You have to attempt only one of the choices in such questions.*

Section 'A'

All questions are compulsory. In case of internal choices, attempt any one of them.

1. A thin rectangular magnet suspended freely has a period of oscillation equal to T. Now, it is broken into two equal halves (each having half of the original length) and one piece is made to oscillate freely in the same field. If its period of oscillation is T', find the ratio of T'/T. **1**

2. If $\vec{E}$ and $\vec{B}$ represent electric and magnetic field vectors of the electromagnetic wave, what will be the direction of propagation of electromagnetic wave ?

OR

Which one of the following will experience maximum force, when projected with the same velocity 'v' perpendicular to the magnetic field 'B': (i) Alpha particle, and (ii) Beta-particle ? **1**

3. A conducting circular loop is placed in a uniform magnetic field B = 0.020 T with its plane perpendicular to the field. The radius of the loop starts shrinking at a constant rate of 1.0 mm/s. Find the induced *e.m.f* in the loop at an instant when the radius is 2 cm . **1**

4. The given figure shows the Wheatstone bridge method for measurement of unknown resistance R. What is the balanced equation for Wheatstone bridge ? **1**

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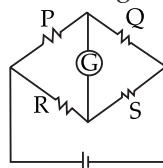
OR

What happens to the magnetic field of the solenoid if a ferromagnetic material is inserted in a current carrying solenoid ?

5. An electron is projected along the axis of a circular conductor carrying the same current. What amount of force will be experienced by the electron ? **1**

6. How the resonant frequency in an L-C-R series circuit with a generator may be reduced ? **1**

7. Will a passenger in an aeroplane be able to see a rainbow ?

OR

An iron-cored solenoid has self-inductance 2.8 H. When the core is removed, the self inductance becomes 2 mH. What is the relative permeability of the core used ? **1**

[AI] 8. In the figure given, mark the polarity of plates A and B of a capacitor when the magnets are quickly moved towards the coil.
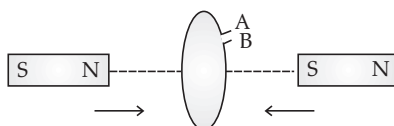
OR

In case of telescope, the adjustment is made so that the final image is at infinity and the eye is completely relaxed when viewing it. What is the name of this adjustment ? **1**

9. What is the principle of the Wheatstone bridge ? **1**

[AI] 10. Plot a graph showing variation of capacitive reactance with the change in the frequency of the *ac* source. **1**

For question numbers 11, 12, 13 and 14, two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is NOT the correct explanation of A

(c) A is true but R is false

(d) A is false and R is also false

11. **Assertion (A) :** At the timing of switching ON and OFF there is a high possibility of an electric bulb to fuse.

   Reason (R) : A surge is produced due to inductive effect at the time of switching ON and OFF. **1**

12. **Assertion (A) :** 200 W lamp glows more brightly compared to 100 W lamp.

   Reason (R) : Resistance of 100 W lamp is more than than that of 200 W lamp. **1**

13. **Assertion(A) :** Fuse wire has high resistance and low melting point.

   Reason (R) : Fuse wire is for small current flow only. **1**

14. **Assertion(A) :** Resistivity of semiconductor increases with increase of temperature.

   Reason (R) : Energy band gap for semiconductor is normally less than 1 eV. **1**

Section 'B'

Questions 15 and 16 are Case Study based questions and are compulsory. Attempt any 4 sub parts from each question. Each question carries 1 mark.

15. **Thermistor :** Thermistor is a type of resistor whose resistance is temperature dependant. The word is a combination of thermal and resistor. Thermistors are of two types :

   NTC Thermistor : Resistance decreases with temperature.

   PTC thermistor : Resistance increases with temperature.

   Thermistors are different from Resistance Temperature Detector (RTD).

   Thermistors are made from ceramic or polymer. RTD's are made from pure metal.

   RTD's are useful for wide temperature range. Thermistors achieve greater precision within a limited temperature range.

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Temperature *vs.* resistance graph of NTC and PTC are as below :
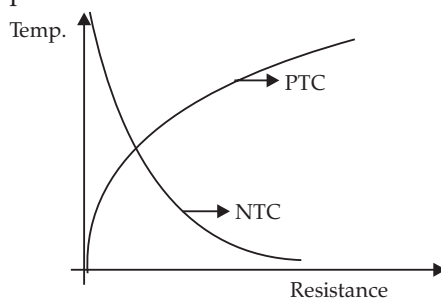
1. Which statement is correct regarding the working temperature range and precision of Thermistor and RTD?
   (a) RTD works in a wide temperature range and precision is not so high. Thermistor works in a narrow temperature range but precision is very high
   (b) RTD works in a narrow temperature range and precision is not so high. Thermistor works in a wide temperature range but precision is very high
   (c) Both are having high precision and wide working temperature range.
   (d) Both are having low precision and narrow working temperature range.   4

2. For NTC thermistor,
   (a) Resistance increases with temperature
   (b) Resistance decrease with temperature
   (c) Resistance does not vary with temperature
   (d) Resistance decreases with temperature upto a definite value and it starts increasing with temperature.

3. Temperature coefficient of PTC thermistor is
   (a) Zero   (b) Positive
   (c) Negative
   (d) Positive at lower temperature range and negative at higher temperature range.

4. Main constituent of thermistor is
   (a) Ceramic   (b) Metal
   (c) Alloy   (d) Metalloid

5. Resistance of thermistor :
   (a) does not very with temperature
   (b) always increases with increase of temperature
   (c) always decreases with increase of temperature
   (d) may increase or decrease with increase of temperature depending on the type

16. **Electric Toaster :** Small Industries Service Institute Takyelpat Industrial Estate Imphal has designed an electric toaster which is operated at 220 volts A.C., single phase and available in four different rated capacity such as 600 W, 750 W, 1000 W and 1250 W. The heating elements is made of nichrome 80/20 (80% nickel, 20% chromium) since Nichrome does not get oxidise readily at high temperature and have higher resistivity. So produces more heat. The element is wound separately on Mica sheets and fitted with body of toaster with the help of ceramic terminals.
   1. Heating element of the toaster is made of
      (a) Copper   (b) Nichrome
      (c) Chromium   (d) Nickel
   2. What is meant by 80/20 Nichrome?
      (a) 80% Chromium and 20% Nickel   (b) 80% Nickel and 20% Chromium
      (c) Purity 80%, Impurity 20%   (d) It is a mixture of Chromium and Nickel

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3. Which one will consume more electricity?
   (a) 600 W   (b) 750 W
   (c) 1000 W   (d) 1200 W
4. Operating voltage of the device is :
   (a) 220 V AC, single phase   (b) 220 V AC, three phase
   (c) 220 V DC   (d) 220 V AC/DC
5. Insulating materials used in the device are :
   (a) Mica   (b) Ceramic
   (c) Mica, ceramic, Nichrome   (d) Mica, ceramic

Section 'C'

*All questions are compulsory. In case of internal choices, attempt anyone.*

17. Show that the current leads the voltage in phase by $\dfrac{\pi}{2}$ in an *ac* circuit containing an ideal capacitor. **2**

18. Define the magnifying power of a compound microscope when the final image is formed at infinity. Why must both the objective and the eyepiece of a compound microscope have short focal lengths ? Explain.

OR

A ray of light falls on a transparent sphere with centre C as shown in the figure. The ray emerges from the sphere parallel to the line AB. Find the angle of refraction at A, if refractive index of the material of the sphere is $\sqrt{3}$. **2**
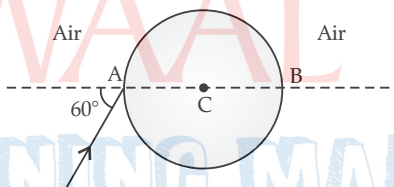
19. The figure shows a ray of light falling normally on the face AB of an equilateral glass prism having refractive index $\dfrac{3}{2}$, placed in water of refractive index $\dfrac{4}{2}$. Will this ray suffer total internal reflection on striking the face AC ? Justify your answer.
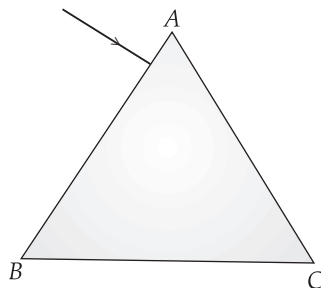
OR

For a glass prism ($\mu = \sqrt{3}$) the angle of minimum deviation is equal to the angle of the prism. Find the angle of the prism.

20. How is electromagnetic wave produced ? Draw a sketch of a plane EM wave propagating along X-axis depicting the directions of the oscillating electric and magnetic fields. **2**

21. Define secondary wavelets and how can we construct new wavefront with them ? **2**

22. Energy gap in a *p-n* photodiode is 2.8 eV. Can it detect a wavelength of 6000 nm ? Justify your answer. **2**

23. Monochromatic light of frequency 6.0×10^{14} Hz is produced by a laser. The power emitted is 2.0×10^{-3} W. Calculate the (i) energy of a photon in the light beam and (ii) number of photons emitted on an average by the source. **2**

24. Plot a graph showing variation of de-broglie wavelength λ versus $\frac{1}{\sqrt{V}}$, where, V is accelerating potential for two particles A and B carrying same charge but of masses m_1, m_2 ($m_1 > m_2$). Which one of the two represents a particle of smaller mass and why ?

OR

The radius of curvature of the curved surface of a planoconvex lens is 20 cm. If the refractive index of the material of the lens be 1.5, how the lens will behave ?   **2**

25. The ground state energy of hydrogen atom is – 13.6 eV. If an electron makes a transition from an energy level – 1.51 eV to – 3.4 eV, calculate the wavelength of the spectral line emitted and the series of hydrogen spectrum to which it belongs.   **2**

Section 'D'

All questions are compulsory. In case of internal choices, attempt any one.

26. With what considerations in view, a photodiode is fabricated ? State its working with the help of a suitable diagram. Even though the current in the forward bias is known to be more than in the reverse bias, yet the photodiode works in reverse bias. What is the reason ?   **3**

27. The figure shows a series LCR circuit connected to a variable frequency 230 V source.
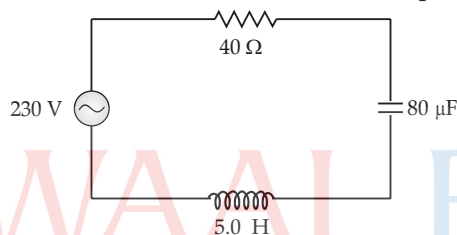
(a) Determine the source frequency which drives the circuit in resonance.

(b) Calculate the impedance of the circuit and amplitude of current at resonance.

(c) Show that potential drop across LC combination is zero at resonating frequency.

OR

Define the term magnetic moment of a current loop. Derive an expression for the magnetic field at any point along the axis of a solenoid of length $2l$, and radius a, and number of turns per unit length n.   **3**

28. Distinguish between nuclear fission and fusion. Show how in both these processes energy is released. Calculate the energy release in MeV in the deuterium-tritium fusion reaction :

$$_1^2H + {}_1^3H \rightarrow {}_2^4He + {}_0n^1$$
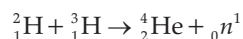
$$m\left({}_1^2H\right) = 2.014102 \text{ u}$$

$$m\left({}_1^3H\right) = 3.016049 \text{ u}$$

$$m\left({}_2^4He\right) = 4.002603 \text{ u}$$

$$m_n = 1.008665 \text{ u}$$

$$1 \text{ amu} = 931.5 \text{ Me}\frac{V}{c^2}$$

OR

(i) Define mutual inductance.

(ii) A pair of adjacent coils has a mutual inductance of 1.5 H. If the current in one coil changes from 0 to 20 A in 0.5 s, what is the change of flux linkage with the other coil ?   **3**

29. Consider a two slit interference arrangement (shown in figure) such that the distance of the screen from the slits is half the distance between the slits. Obtain the value of D in terms of λ such that the first minima on the screen falls at a distance D from the centre O.   **3**

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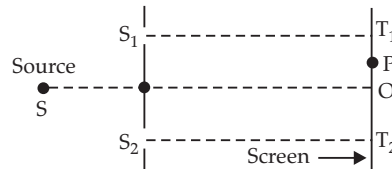
30. Define the term "cut off frequency" in photoelectric emission. The threshold frequency of a metal is f. When the light of frequency $2f$ is incident on the metal plate, the maximum velocity of photoelectrons is v_1. When the frequency of the incident radiation is increased to $5f$, the maximum velocity of photo-electrons is v_2. Find the ratio $v_1 : v_2$. **3**

Section 'E'

All questions are compulsory. In case of internal choices, attempt any one.

31. **(i)** **(a)** State the principle on which a potentiometer works. How can a given potentiometer be made more sensitive ?
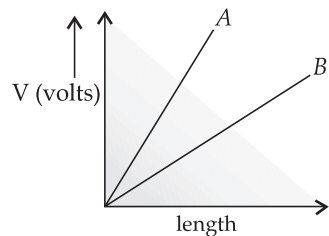

   (b) In the graph shown below for two potentiometers, state with reason which of the two potentiometers, A or B, is more sensitive.

   (ii) Two metallic wires, P_1 and P_2 of the same material and same length but different cross-sectional areas, A_1 and A_2 are joined together and connected to a source of emf. Find the ratio of the drift velocities of free electrons in the two wires when they are connected (i) in series, and (ii) in parallel. **5**

OR

   (i) A metallic rod of length l is moved perpendicular to its length with velocity v in a magnetic field B acting perpendicular to the plane in which rod moves. Derive the expression for the induced *emf*.

   (ii) A wheel with 15 metallic spokes each 60 cm long, is rotated at 360 rev/min in a plane normal to the horizontal component of earth's magnetic field, the angle of dip at that place is 60°. If the emf induced between rim of the wheel and the axle is 400 mV, calculate the horizontal component of earth's magnetic field at the place. How will the induced emf change, if the number of spokes is increased ?

🔲 32.**(i)** A hollow cylindrical box of length 1 m and area of cross-section 25 cm^2 is
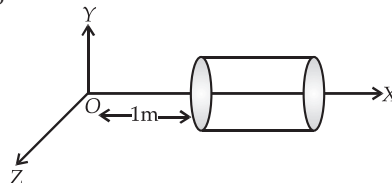
   placed in a three dimensional co-ordinate system as shown in the figure. The electric field in the region is given by $\vec{E} = 50\, x\,\hat{i}$, where E is in NC^{-1} and x is in metres.
   Find
   (a) Net flux through the cylinder.
   (b) Charge enclosed by the cylinder. **3**

   (ii) A 12 pF capacitor is connected to a 50 V battery. How much electrostatic energy will be stored in it ? When a 6 pF capacitor is connected in series with it, find the charge stored. **2**

OR

A device X is connected across an *ac* source of voltage $V = V_0 \sin t$. The current through X is given as

$I = I_0 \sin(\omega t + \dfrac{\pi}{2})$.

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(a) Identify the device X and write the expression for its reactance.

(b) Draw graphs showing variation of voltage and current with time over one cycle of *ac*, for X.

(c) How does the reactance of the device X vary with frequency of the *ac* ? Show this variation graphically.

(d) Draw the phasor diagram for the device X. **5**

33. (i) Define the capacitance of a capacitor. Obtain the expression for the capacitance of a parallel plate capacitor in vacuum in terms of plate area A and separation *d* between the plates.

(ii) A slab of material of dielectric constant *k* has the same area as the plates of a parallel plate capacitor but has a thickness $\dfrac{3d}{4}$. Find the ratio of the capacitance with dielectric inside it to its capacitance without the dielectric. **5**

OR

(a) State the principle of working of a transformer.

(b) Define efficiency of a transformer.

(c) State any two factors that reduce the efficiency of a transformer.

(d) Calculate the current drawn by the primary of a 90% efficient transformer which steps down 220 V to 22 V, if the output resistance is 440 Ω.

■■■

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