

PET-18  
QUESTION PAPER

1. Let  $y_1(x)$  and  $y_2(x)$  be two linearly independent solutions of the differential equation

$$\frac{d^2y}{dx^2} + 2\frac{dy}{dx} + f(x)y = 0$$

and

$$W(x) = y_1(x)\frac{dy_2}{dx} - y_2(x)\frac{dy_1}{dx}$$

If  $y(0)=1$ , then  $y(1)$  is given by

- (a) 1  
 (b)  $\frac{1}{e}$   
 (c)  $\frac{1}{e^2}$   
 (d)  $\frac{1}{e^3}$
2. The value of the integral  $\int \frac{z^3}{z^2-5z+6} dz$  over a closed contour defined by equation  $2|z|-5=0$  transverse in the anticlockwise direction is  
 (a)  $-16\pi i$   
 (b)  $16\pi i$   
 (c)  $8\pi i$   
 (d)  $4\pi i$
3.  $\text{SiO}_2$  is used in MOSFETs because  
 (a) It increases input impedance  
 (b) It decreases input impedance  
 (c) It is a good conductor  
 (d) It acts as top protective layer
4. A proton is confined in a nucleus of radius  $10^{-14}$  m. The minimum kinetic energy of the proton is  
 (a) 1.20 GeV  
 (b) 2.20 GeV  
 (c) 1.08 KeV  
 (d) 0.208 MeV
5. Which of the following nuclear reaction is allowed?  
 (a)  $p \rightarrow n + e^+ + \nu_e$   
 (b)  $p \rightarrow e^+ + \nu_e$   
 (c)  $p \rightarrow \pi^+ + \gamma$   
 (d)  $n \rightarrow \pi^- + \pi^0$
6. A Geiger Muller counter has a dead time of  $600 \mu\text{s}$ . What is the true counting rate if observed counting rate is 1000 counts/min?  
 (a) 1000 counts/min  
 (b) 990 counts/min  
 (c) 1010 counts/min  
 (d) None of these

7. The volume of a cell in six dimensional phase space is  
 (a)  $h^3$   
 (b)  $h^6$   
 (c)  $h^{-3}$   
 (d)  $h^{-6}$
8. The probability that a state which is 0.2 eV above the Fermi energy in a metal at 700K is occupied is  
 (a) 96.2%  
 (b) 3.5%  
 (c) 37.7%  
 (d) 62.3%
9. What is the sum of residues of function  $F(z)=e^z/(z^2+a^2)$  is  
 (a)  $\text{Cos}(a)/a$   
 (b)  $\text{Sin}(a)/a$   
 (c) Zero  
 (d) Infinite
10. What is the value of  $[\sigma_x, \sigma_y]$ :  
 (a)  $2i \sigma_z$   
 (b)  $\sigma_z$   
 (c)  $-2i \sigma_z$   
 (d)  $-i \sigma_z$
11. According to quantum mechanics, for particle in a box:  
 (a) The energy levels are discrete  
 (b) The energy levels are continuous  
 (c) The energy levels are discrete but not equispaced  
 (d) The energy levels are discrete but equispaced
12. At low temperature, specific heat of metal can be expressed as  
 (a)  $aT^3$   
 (b)  $aT^3+bT^2$   
 (c)  $aT+bT^3$   
 (d)  $aT^2+bT^3$
13. Which one of the following is not an exact differential:  
 (a)  $dU$  ( $U$ =internal energy)  
 (b)  $dS$  ( $S$ =entropy)  
 (c)  $dQ$  ( $Q$ =heat absorbed)  
 (d)  $dF$  ( $F$ =Helmholtz free energy)
14. A cube has edge  $L_0$  when at rest. If the cube moves with velocity  $v$  parallel to its one edge, then its volume becomes:  
 (a)  $L_0^3(1-v^2/c^2)^{1/2}$   
 (b)  $L_0^3(1-v^2/c^2)^2$   
 (c)  $L_0^3(1-v^2/c^2)^{-1/2}$   
 (d)  $L_0^3(1-v^2/c^2)^{-1}$

15. A certain p-channel enhancement type MOSFET has  $V_{GS} = -2V$ . If  $V_{GS} = 0V$ , then the drain current is:
- 0
  - $I_{D(on)}$
  - Maximum
  - $I_{DSS}$
16. Hamiltonian of sun-earth system:
- Is a constant of motion
  - Is a function of position of earth and sun
  - Increases with time
  - Decreases with time due to friction
17. In observing Raman spectrum of the sample, using  $2537 \text{ \AA}$  as the exciting line, one gets Stoke's line at  $2683 \text{ \AA}$ . The Raman shift in  $\text{cm}^{-1}$  units is:
- $2.145 \times 10^3 \text{ cm}^{-1}$
  - $1.145 \times 10^3 \text{ cm}^{-1}$
  - $4.145 \times 10^3 \text{ cm}^{-1}$
  - $7.145 \times 10^2 \text{ cm}^{-1}$
18. In a photoelectric effect experiment, ultraviolet light of wavelength  $320 \text{ nm}$  falls on the photocathode with work function of  $2.1 \text{ eV}$ . The stopping potential should be close to
- $1.8 \text{ V}$
  - $1.6 \text{ V}$
  - $2.2 \text{ V}$
  - $2.4 \text{ V}$
19. Quarks exist in the following number of flavors:
- Two
  - Four
  - Six
  - Ten
20. If the surface integral of the field  $\vec{A}(x, y, z) = 2\alpha x\hat{i} + \beta y\hat{j} - 3\gamma z\hat{k}$  over the closed surface of an arbitrary unit sphere is to be zero, then the relationship between  $\alpha, \beta, \gamma$  is
- $\alpha + \frac{\beta}{6} - \gamma = 0$
  - $\frac{\alpha}{3} + \frac{\beta}{6} - \frac{\gamma}{2} = 0$
  - $\frac{\alpha}{2} + \beta - \frac{\gamma}{3} = 0$
  - $\frac{2}{\alpha} + \frac{1}{\beta} - \frac{3}{\gamma} = 0$
21. The frame  $S'$  is moving with speed  $c/2$  with respect to frame  $S$ , where  $c$  is the speed of light. In the frame  $S$ , two separate events occur at  $(x_1, t_1)$  and  $(x_2, t_2)$ . In the frame  $S'$ , these events occur simultaneously. The value of  $\frac{(x_2 - x_1)}{(t_2 - t_1)}$  is
- $c/4$

- (b)  $c/2$   
 (c)  $2c$   
 (d)  $c$
22. A proton from outer space is moving towards earth with velocity  $0.99c$  as measured in earth's frame. A space shuttle travelling parallel to the proton, measures proton's velocity to be  $0.97c$ . The approximate velocity of the space shuttle, in the earth's frame, is  
 (a)  $0.2c$   
 (b)  $0.3c$   
 (c)  $0.4c$   
 (d)  $0.5c$
23. Four particles of mass  $m$  each are inside a two dimensional square box of side  $L$ , if each state obtained from the solution of the Schrodinger equation is occupied by only one particle, the minimum energy of the system in units of  $\frac{h^2}{mL^2}$  is  
 (a) 2  
 (b)  $5/2$   
 (c)  $11/2$   
 (d)  $25/4$
24. A charge  $q$  is at the center of two concentric spheres. The outward electric flux through the inner sphere is  $\Phi$  while that through the outer sphere is  $2\Phi$ . The amount of charge contained in the region between the two spheres is  
 (a)  $2q$   
 (b)  $q$   
 (c)  $-q$   
 (d)  $-2q$
25. A small charged spherical shell of radius  $0.01$  m is at a potential of  $30$  V. The electrostatic energy of the shell is  
 (a)  $10^{-10}$  J  
 (b)  $5 \times 10^{-10}$  J  
 (c)  $5 \times 10^{-9}$  J  
 (d)  $10^{-9}$  J
26. A ring of radius  $R$  carries a linear charge density  $\lambda$ . It is rotating with an angular speed  $\omega$ . The magnetic field at its center is  
 (a)  $\frac{3\mu_0\lambda\omega}{2}$   
 (b)  $\frac{\mu_0\lambda\omega}{2}$   
 (c)  $\frac{\mu_0\lambda\omega}{\pi}$   
 (d)  $\mu_0\lambda\omega$
27. If the energy of a quantum harmonic oscillator is  $E_n = nh\nu$ ,  $n=0,1,2,\dots$ , the partition function of the system of oscillator is  
 (a)  $e^{-\frac{h\nu}{KT}}$

- (b)  $e^{\frac{h\nu}{kT}}$   
 (c)  $\frac{1}{e^{\frac{h\nu}{kT}} - 1}$   
 (d)  $\frac{1}{1 - e^{\frac{h\nu}{kT}}}$

28. Two classical particles have energy states  $E=0, \epsilon, 2\epsilon$  with degeneracies 1, 2, 4, respectively. How many total configurations possible for this system?  
 (a) 16  
 (b) 21  
 (c) 20  
 (d) 18
29. Electrical resistance of niobium which shows superconductivity transition at 9.2 K is  
 (a) Zero at all temperatures below 9.2 K  
 (b) Zero at absolute zero but non zero at temperatures above it  
 (c) Decreases with increase in temperature above 9.2 K  
 (d) Infinite at 9.2 K
30. A nucleus has a size of  $10^{-15}$  m. Consider an bound electron within a nucleus. The estimated energy of this electron is of the order of  
 (a) 1 MeV  
 (b)  $10^2$  MeV  
 (c)  $10^4$  MeV  
 (d)  $10^6$  MeV
31. When angle of incidence is greater than Brewster angle, the reflected ray suffers a phase change of  
 (a)  $\pi$   
 (b)  $\pi/2$   
 (c) 0  
 (d)  $2\pi$
32. Which one of the following semiconductor devices is used as temperature sensor?  
 (a) Thermistor  
 (b) Schottky Diode  
 (c) Zener Diode  
 (d) Thermocouple
33. The depletion region in a p-n junction is created by  
 (a) Ionization  
 (b) Diffusion  
 (c) Recombination  
 (d) All of above
34. If 50 kV is the applied potential in X-ray tube, the minimum wavelength of X-rays produced is  
 (a) 0.2 nm

- (b) 2 nm
- (c) 0.2 Å
- (d) 2 Å

35. L-S coupling often occurs for

- (a) All atoms
- (b) Lighter atoms
- (c) Heavier atoms
- (d) Only in nuclei

36. According to Maxwell law of distribution of velocities of molecules the most probable velocity is

- (a) Greater than the mean velocity
- (b) Equal to mean velocity
- (c) Equal to root mean square velocity
- (d) Less than root mean square velocity

37. In the original BCS model of superconductivity the dependence of  $T_c$  on isotope mass is

- (a)  $T_c \propto M^{-1}$
- (b)  $T_c \propto M$
- (c)  $T_c \propto M^{-1/2}$
- (d)  $T_c \propto M^{1/2}$

38. A planet of mass  $m$  moves in the gravitational field of the Sun (mass  $M$ ). If the semi-major and semi-minor axes of the orbit are  $a$  and  $b$ , respectively, the angular momentum of the planet is

- (a)  $\sqrt{2GMm^2(a+b)}$
- (b)  $\sqrt{2GMm^2(a-b)}$
- (c)  $\sqrt{2GMm^2\left(\frac{ab}{a-b}\right)}$
- (d)  $\sqrt{2GMm^2\left(\frac{ab}{a+b}\right)}$

39. The total number of nearest neighbors in bcc is

- (a) 12
- (b) 8
- (c) 6
- (d) 4

40. The electric field in a system is given by  $\vec{E} = ax\hat{i} + cz\hat{j} + 6by\hat{k}$ . For which values of  $a$ ,  $b$ , and  $c$  does this represent the electrostatic field

- (a) 13, 1, 12
- (b) 17, 6, 1
- (c) 13, 1, 6
- (d) 45, 6, 1

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ANSWER KEY  
B418SP31

1. (c)
2. (a)
3. (a)
4. (b)
5. (a)
6. (c)
7. (a)
8. (b)
9. (b)
10. (a)
11. (c)
12. (c)
13. (c)
14. (a)
15. (a)
16. (a)
17. (a)
18. (a)
19. (c)
20. (b)
21. (c)
22. (d)
23. (b)
24. (b)
25. (b)
26. (b)
27. (c)
28. (b)
29. (b)
30. (b)
31. (a)
32. (a)
33. (d)
34. (c)
35. (b)
36. (d)
37. (c)
38. (d)
39. (b)
40. (c)