2011 PH 40-52

AI24BTECH11031 - Shivram S

1) The isospin and the strangeness of Ω^- baryon are

    a) $1, -3$
    b) $0, -3$
    c) $1, 3$
    d) $0, 3$

2) The lifetime of an atomic state is 1 nanosecond. The natural line width of the spectral line in the emission spectrum of this state is of the order of

    a) 10^{-10} eV
    b) 10^{-9} eV
    c) 10^{-6} eV
    d) 10^{-4} eV

3) The degeneracy of an excited state of nitrogen atom having electronic configuration $1s^2 2s^2 2p^2 3d^1$ is

    a) 6
    b) 10
    c) 15
    d) 150

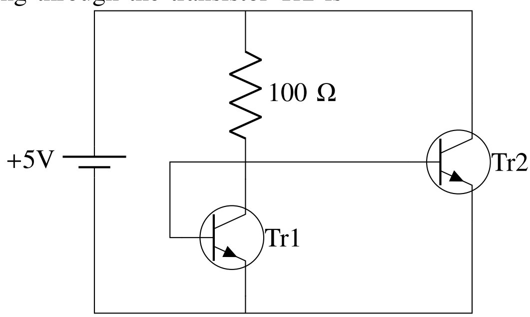
4) The far infrared rotational absorption spectrum of a diatomic molecule shows equidistant lines with spacing 20 cm^{-1}. The position of the first Stokes line in the rotational Raman spectrum of this molecule is

    a) 20 cm^{-1}
    b) 40 cm^{-1}
    c) 60 cm^{-1}
    d) 120 cm^{-1}

5) A metal with body centered cubic (bcc) structure shows the first (i.e. smallest angle) diffraction peak at a Bragg angle of $\theta = 30°$. The wavelength of X-ray used is 2.1 Å. The volume of the primitive unit cell of the metal is

    a) $26.2\ (\text{Å})^3$
    b) $13.1\ (\text{Å})^3$
    c) $9.3\ (\text{Å})^3$
    d) $4.6\ (\text{Å})^3$

6) In the following circuit, Tr1 and Tr2 are identical transistors having $V_{BE} = 0.7$ V. The current passing through the transistor Tr2 is



a) 57 mA b) 50 mA c) 48 mA d) 43 mA

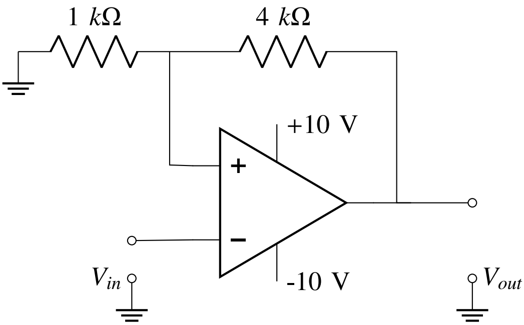
7) The following Boolean expression

$$Y = A\cdot\overline{B}\cdot\overline{C}\cdot\overline{D} + \overline{A}\cdot B\cdot\overline{C}\cdot D + \overline{A}\cdot\overline{B}\cdot\overline{C}\cdot D + \overline{A}\cdot\overline{B}\cdot C\cdot D + \overline{A}\cdot B\cdot C\cdot D + A\cdot\overline{B}\cdot\overline{C}\cdot D$$

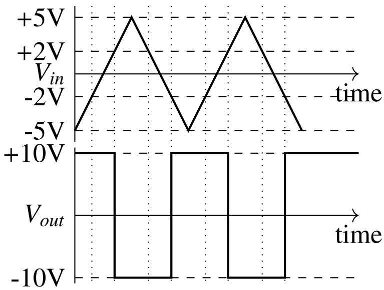
can be simplified to

a) $\overline{A}\cdot\overline{B}\cdot C + A\cdot\overline{D}$
b) $\overline{A}\cdot B\cdot\overline{C} + A\cdot\overline{D}$
c) $A\cdot\overline{B}\cdot\overline{C} + \overline{A}\cdot D$
d) $A\cdot\overline{B}\cdot C + \overline{A}\cdot D$

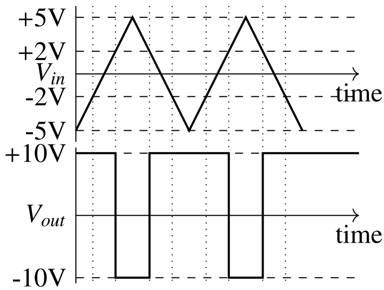
8) Consider the following circuit.



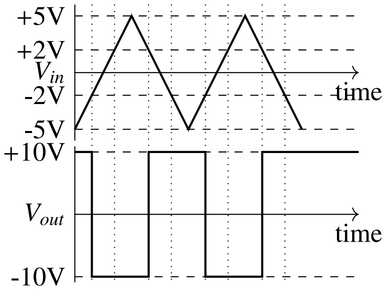
Which of the following correctly represents the output V_{out} corresponding to the input V_{in}?



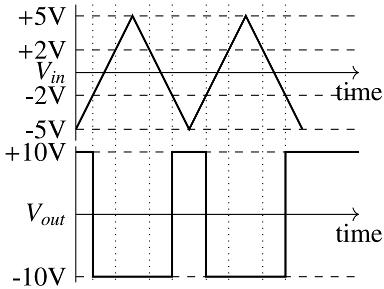
a)



c)



b)



d)

Common Data for Questions 48 and 49:
Consider a function $f(z) = \frac{z \sin z}{(z-\pi)^2}$ of a complex variable z.

9) Which of the following statements is **TRUE** for the function $f(z)$?
   a) $f(z)$ is analytic everywhere in the complex plane
   b) $f(z)$ has a zero at $z = \pi$
   c) $f(z)$ has a pole of order 2 at $z = \pi$
   d) $f(z)$ has a simple pole at $z = \pi$

10) Consider a counterclockwise circular contour $|z| = 1$ about the origin. The integral $\oint f(z)\, dz$ over this contour is

   a) $-i\pi$ b) zero c) $i\pi$ d) $2i\pi$

Common Data for Questions 50 and 51:
The tight binding energy dispersion $(E - k)$ relation for electrons in a one-dimensional array of atoms having lattice constant a and total length L is

$$E = E_0 - \beta - 2\gamma \cos(ka),$$

where E_0, β, and γ are constants and k is the wave-vector.

11) The density of states of electrons (including spin degeneracy) in the band is given by

   a) $\frac{L}{\pi\gamma a \sin(ka)}$ b) $\frac{L}{2\pi\gamma a \sin(ka)}$ c) $\frac{L}{2\pi\gamma a \cos(ka)}$ d) $\frac{L}{\pi\gamma a \cos(ka)}$

12) The effective mass of electrons in the band is given by

   a) $\frac{\hbar^2}{\gamma a^2 \cos(ka)}$ b) $\frac{\hbar^2}{2\gamma a^2 \cos(ka)}$ c) $\frac{\hbar^2}{\gamma a^2 \sin(ka)}$ d) $\frac{\hbar^2}{2\gamma a^2 \sin(ka)}$

Statement for Linked Answer Questions 52 and 53:
In a one-dimensional harmonic oscillator, φ_0, φ_1, and φ_2 are respectively the ground, first, and second excited states. These three states are normalized and are orthogonal to one another. ψ_1 and ψ_2 are two states defined by

$$\psi_1 = \varphi_0 - 2\varphi_1 + 3\varphi_2$$
$$\psi_2 = \varphi_0 - \varphi_1 + \alpha\varphi_2$$

where α is a constant.

13) The value of α for which ψ_2 is orthogonal to ψ_1 is

   a) $\hbar\omega$ b) $\frac{3\hbar\omega}{2}$ c) $3\hbar\omega$ d) $\frac{9\hbar\omega}{2}$