1. **(Total 60%)** A uniform plane wave originating in lossless dielectric medium 1 ($\varepsilon_1 = 16\varepsilon_0$), which occupies the half-space region of $z \leq 0$, is incident normally on a plane interface with a lossy dielectric medium 2 ($\varepsilon_2 = 2\varepsilon_0 - j2\sqrt{3}\varepsilon_0$), which occupies the half-space region of $z \geq 0$. The operating frequency of the plane wave is $\frac{1}{2\pi} \times 3 \times 10^8$ Hz. Assuming the incident magnetic field intensity to be $\underline{H} = \underline{y}_0 \frac{1}{30\pi} e^{-j\beta_1 z}$,

   a) find the propagating vector of the transmitted wave in medium 2. **(10%)**
   b) find the general solutions for the reflected electric field in the region $z \leq 0$ (Assume the magnitude of the reflected electric field intensity is $E_{r0}$, where $E_{r0}$ is a real constant). **(10%)**
   c) find the general solutions for the transmitted magnetic field intensity in the region $z \geq 0$ (Assume the magnitude of the transmitted magnetic intensity is $H_{t0}$, where $H_{t0}$ is a real constant). **(10%)**
   d) determine the reflection and transmission coefficients at the boundary $z = 0$. **(10%)**
   e) using cosine reference, find the time-domain instantaneous expression of the total electric field intensity in medium 1 ($z \leq 0$). **(10%)**
   f) find the locations of the occurrence of the minimum of $|\underline{E}|$ in medium 1 ($z \leq 0$). **(10%)**

2. **(Total 16%)** Write down the following. :
   a) The fundamental postulates for electrostatics. **(4%)**
   b) The mathematical expression (in its integral form) for Gauss's Law. **(2%)**
   c) The Maxwell's equations. **(8%)**
   d) The mathematical expression for Ampere's Law. **(2%)**

3. **(Total 24%)** Choose the correct answer(s):
   1) If two vectors $\underline{A}$ and $\underline{B}$ are parallel to each other, $\underline{A} \, // \, \underline{B}$, which of the following are true? **(3%)**
      (a) The absolute value of inner product of $\underline{A}$ and $\underline{B}$ is maximum; (b) $\underline{A} \cdot \underline{B} = 0$; (c) $\underline{A} \times \underline{B} = 0$; (d) $\underline{A} + \underline{B} = 1$.
   2) Which of the following statements are true? **(3%)**
      (a) The area of the parallelogram spanned by two vectors $\underline{A}$ and $\underline{B}$ is $|\underline{A} \times \underline{B}|$ ; (b) If $\underline{A} \cdot \underline{B} = \underline{A} \cdot \underline{C}$ then $\underline{B} = \underline{C}$; (c) If $\underline{A} \times \underline{B} = \underline{A} \times \underline{C}$ then $\underline{B} = \underline{C}$; (d) If $\underline{A} \cdot \underline{B} \times \underline{C} = 0$ then the three vectors $\underline{A}, \underline{B}$ and $\underline{C}$ lie in the same plane.
   3) Which of the following are true? **(3%)**
      (a) $\nabla \times (\nabla V) = 0$ ; (b) $\int_V (\nabla \cdot \underline{A}) dv = \oint_C \underline{A} \cdot d\underline{l}$ ;(c) $\nabla \cdot (\nabla \times \underline{A}) = 0$ ;(d) $\int_S (\nabla \times \underline{A}) \cdot d\underline{s} = \oint_C \underline{A} \times d\underline{l}$
   4) A small circular loop with radius $b$ is centered at the origin and carrying a current $I$ in the $\phi$-direction. For an observation point located at a distance $r$ from the origin ($r >> b$), which of the following are true? **(3%)**
      (a) The magnetic vector potential $\underline{A}$ due to the current-carrying loop is inversely proportional to $r^2$;
      (b) The magnetic flux density $\underline{B}$ due to the current-carrying loop is inversely proportional to $r^2$;
      (c) The magnetic flux density $\underline{B}$ due to the current-carrying loop is zero at any points on the z-axis;
      (d)The magnetic flux density $\underline{B}$ due to the current-carrying loop is in the z-direction at any points

on the z-axis.

5) In rectangular coordinate system, two point charges $+Q$, and $-Q$ locate at $(0,0,d/2)$ and $(0,0,-d/2)$ on z-axis, respectively. Such a set of two charges can be treated as the electric dipole. For an observation point located at a distance $r$ from the origin ($r >> d$), which of the followings are true? **(3%)**

(a) The electric field intensity $\underline{E}$ due to the system of charges is inversely proportional to $r^3$

(b) The scalar electric potential $V$ due to the system of charges is inversely proportional to $r$;

(c) The potential is zero everywhere in the x-y plane ;

(d) The total work required to hold the two charges in place is zero.

6) A lossless transmission line of $50\Omega$ characteristic impedance is terminated with a load impedance of $Z_L = 30\Omega$. The SWR of the transmission line is: **(3%)**

(a)1/4; (b) 3/5; (c) 5/3; (d) 1.5.

7) A $50\Omega$ transmission line shows a SWR of 2. One of the voltage maxima along the line is a half-wavelength away from the load. The load impedance is: **(3%)**

(a)100 $\Omega$; (b) 150 $\Omega$; (c) 75 $\Omega$; (d) 50 $\Omega$.

8) A $40\Omega$ coaxial cable with dielectric constant 4 is inserted between the load with $Z_L = 32\Omega$ and the source with $Z_S = 50\Omega$. What is the shortest length of the cable such that the load is perfectly matched to the source at 0.1 GHz? **(3%)**

(a)0.5m ; (b) 1m; (c) 0.75m; (d)0.375m.