

# Unit 11 - Week 8

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## Assignment 8

The due date for submitting this assignment has passed. **Due on 2019-09-25, 23:59 IST.**  
 As per our records you have not submitted this assignment.

- The centred two point finite difference formula for approximating the first derivative of a function  $f(z)$  at a point  $z_0$  is given by: 1 point

$(f(z_0 + \Delta z/2) - f(z_0 - \Delta z/2))/(\Delta z)^2$   
  $(f(z_0) - f(z_0 - \Delta z/2))/\Delta z$   
  $(f(z_0) - f(z_0 - \Delta z/2))/(\Delta z)^2$   
  $(f(z_0 + \Delta z/2) - f(z_0 - \Delta z/2))/\Delta z$

**No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
 $(f(z_0 + \Delta z/2) - f(z_0 - \Delta z/2))/\Delta z$
- The value of magnetic field at the centre of a Yee cell  $H_z(i + 0.5, j + 0.5)$  for 2D TE polarization can be calculated as (where  $\dot{E}$  is the time derivative of electric field) 1 point

$H_z(i - 0.5, j + 0.5) + \epsilon_0 \Delta y \dot{E}_x(i + 0.5, j + 0.5)$   
  $H_z(i - 0.5, j - 0.5) + \epsilon_0 \Delta y \dot{E}_x(i + 0.5, j - 0.5)$   
  $H_z(i + 0.5, j - 0.5) + \epsilon_0 \Delta y \dot{E}_x(i + 0.5, j)$   
  $H_z(i - 0.5, j - 0.5) + \epsilon_0 \Delta y \dot{E}_x(i + 0.5, j)$

**No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
 $H_z(i + 0.5, j - 0.5) + \epsilon_0 \Delta y \dot{E}_x(i + 0.5, j)$
- The time update equation for electric field at integer time instance in 2D TE polarization is given by 1 point

$\vec{E}^{n-1} + \frac{\Delta t}{\epsilon_0} [\nabla \times \vec{H}^{n-1/2}]$   
  $\vec{E}^{n-1} - \frac{\Delta t}{\epsilon_0} [\nabla \times \vec{H}^{n-1/2}]$   
  $\vec{E}^{n-1} + \frac{\Delta t}{2\epsilon_0} [\nabla \times \vec{H}^{n-1/2}]$   
  $\vec{E}^{n-1} - \frac{\Delta t}{2\epsilon_0} [\nabla \times \vec{H}^{n-1/2}]$

**No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
 $\vec{E}^{n-1} + \frac{\Delta t}{\epsilon_0} [\nabla \times \vec{H}^{n-1/2}]$
- The divergence of the electric field in a heterogeneous region (characterized by  $\epsilon(r)$ ), is given by the following equation: 1 point

$\nabla \cdot \vec{E} = 0$   
  $\nabla \cdot \vec{E} = -\frac{1}{\epsilon} (\vec{E} \cdot \nabla \epsilon)$   
  $\nabla \cdot \vec{E} = \rho/\epsilon$   
  $\nabla \cdot \vec{E} = -\frac{1}{\epsilon} (\vec{E} \cdot \nabla \epsilon) + \rho/\epsilon$

**No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
 $\nabla \cdot \vec{E} = -\frac{1}{\epsilon} (\vec{E} \cdot \nabla \epsilon) + \rho/\epsilon$
- The Courant stability criteria states that time step in 3D with discretization  $\Delta x = \Delta y = \Delta z = \Delta s$  satisfies which of the following condition 1 point

$\Delta t \geq c/\Delta s$   
  $\Delta t \leq c/\Delta s$   
  $\Delta t \geq \Delta s/\sqrt{2}c$   
  $\Delta t \leq \Delta s/\sqrt{3}c$

**No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
 $\Delta t \leq \Delta s/\sqrt{3}c$
- Numerical dispersion in 1D FDTD occurs when the Courant factor ( $\alpha$ ) is 1 point

$\alpha = 1$   
  $\alpha = 0.5$   
  $\alpha = 1/\sqrt{2}$   
 All of the above

**No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
 $\alpha = 0.5$   
 $\alpha = 1/\sqrt{2}$
- For a perfect electric conductor, the update equation for electric field  $E$  becomes 1 point

$\vec{E}^n = -\vec{E}^{n-1}$   
  $\vec{E}^n = \vec{E}^{n-1}$   
  $\vec{E}^n = \vec{E}^{n-1} + \frac{\Delta t}{\epsilon_0} [\nabla \times \vec{H}^{n-1/2}]$   
  $\vec{E}^n = \vec{E}^{n-1} - \frac{\Delta t}{\epsilon_0} [\nabla \times \vec{H}^{n-1/2}]$

**No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
 $\vec{E}^n = -\vec{E}^{n-1}$
- If the frequency domain relation between electric displacement ( $D$ ) and field ( $E$ ) is given by  $\tilde{D}(\omega) = \tilde{\epsilon}_r(\omega)\tilde{E}(\omega)$  with  $\epsilon_r(t) = \epsilon_r\delta(t)$ , then the time domain relation is given by 1 point

$D(t) = 1$   
  $D(t) = \epsilon_r\epsilon_0 E(t)$   
  $D(t) = \epsilon_r^2\epsilon_0 E(t)$   
  $D(t) = \frac{1}{\epsilon_r}\epsilon_0 E(t)$

**No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
 $D(t) = \epsilon_r\epsilon_0 E(t)$
- According to the Debye model, the permittivity  $\epsilon_r(t)$  at the relaxation time  $t = \tau$  is: According to the Debye model, the permittivity  $\epsilon_r(t)$  at the relaxation time  $t = \tau$  is: 1 point

$\epsilon_r(t) = \epsilon_\infty$   
  $\epsilon_r(t) = \epsilon_s - \epsilon_\infty$   
  $\epsilon_r(t) = (\epsilon_s - \epsilon_\infty)/\tau$   
  $\epsilon_r(t) = (\epsilon_s - \epsilon_\infty)/(e\tau)$

**No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
 $\epsilon_r(t) = (\epsilon_s - \epsilon_\infty)/(e\tau)$
- The second order absorbing boundary condition to minimize reflections at  $30^\circ$  and  $60^\circ$  for a right traveling wave incident on a wall along  $\hat{y}$  is given by: 1 point

$\left(\frac{\partial}{\partial x} + \frac{\sqrt{3}}{2c}\right)\left(\frac{\partial}{\partial x} + \frac{1}{2c}\right)E = 0$   
  $\left(\frac{\partial}{\partial x} - \frac{\sqrt{3}}{c}\right)\left(\frac{\partial}{\partial x} + \frac{1}{2c}\right)E = 0$   
  $\left(\frac{\partial}{\partial x} - \frac{\sqrt{3}}{2c}\right)\left(\frac{\partial}{\partial x} + \frac{1}{2c}\right)E = 0$   
  $\left(\frac{\partial}{\partial x} + \frac{\sqrt{3}}{c}\right)\left(\frac{\partial}{\partial x} + \frac{1}{2c}\right)E = 0$

**No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
 $\left(\frac{\partial}{\partial x} + \frac{\sqrt{3}}{2c}\right)\left(\frac{\partial}{\partial x} + \frac{1}{2c}\right)E = 0$