Assignment4

1) Given a 2D computational domain with absorbing boundary condition, the angle of incidence θ at which the incident wave strikes the boundary resulting in a reflection coefficient of |r|^2 for first order and second order truncation is given by

- 22.5° and 45° respectively.
- 11.42° and 35° respectively.
- 10.45° and 28.6° respectively.
- 17.6° and 40.2° respectively.

Accepted Answers:
11.42° and 35° respectively.

2) For Silver-Müller absorbing boundary condition

- Only tangential component of electric field is computed at the boundary while the tangential component of magnetic field is zero.
- Only tangential component of the magnetic field is computed at the boundary while the tangential component of electric field is zero.
- Tangential components of electric and magnetic fields are computed at the boundary and they are non-zero.
- None of the above.

Accepted Answers:
Tangential components of electric and magnetic fields are computed at the boundary and they are non-zero.

3) Which of the following statement(s) is/are true for PML?

- Statement 1: By rule of thumb the PML thickness should be at least 1λ, where λ corresponds to the wavelength of the lowest frequency component.
- Statement 2: By rule of thumb the PML thickness must be at least 1λ, where λ corresponds to the wavelength of the highest frequency component.
- Statement 3: Only E fields are absorbed in the PML.
- Statement 4: Only H fields are absorbed in the PML.
- Statement 5: PML requires no truncating boundary conditions.

Accepted Answers:
Only statement 2 is correct, but not others.
4) PML is said to be advantageous over absorbing boundary condition because

Statement 1: The computational cost is reduced.
Statement 2: Theoretically no reflection will occur at the interface for any angle of incidence of the incoming wave.
Statement 3: The total computational domain needed for simulation can be reduced.
Statement 4: Accuracy of PML is three times more than that of absorbing boundary condition.

- Only statement 1 is correct, but not others.
- Only statement 2 is correct, but not others.
- Only statement 3 is correct, but not others.
- Only statement 4 is correct, but not others.
- Statements 1 and 2 are correct, but not others.
- Statements 2 and 3 are correct, but not others.
- Statements 1, 2 and 3 are correct, but not 4.
- Statements 1, 2 and 4 are correct, but not 3.
- Statements 1, 3 and 4 are correct, but not 2.
- Statements 2, 3 and 4 are correct, but not 1.

**Accepted Answers:**

Statements 2 and 3 are correct, but not others.

5) Which of the following is/are true for Bérenger PML?

Statement 1: There are electric and magnetic losses.
Statement 2: The permittivity and permeability inside the PML are scalars.
Statement 3: Only permittivity is scalar while permeability is tensor inside the PML.
Statement 4: Only permittivity is tensor while permeability is scalar inside the PML.

- Only statement 1 is correct, but not others.
- Only statement 2 is correct, but not others.
- Only statement 3 is correct, but not others.
- Only statement 4 is correct, but not others.
- Statements 1 and 2 are correct, but not others.
- Statements 1 and 3 are correct, but not others.
- Statements 1 and 4 are correct, but not others.
- Statements 2 and 3 are correct, but not others.
- Statements 2 and 4 are correct, but not others.
- Statements 3 and 4 are correct, but not others.
- None of the statements are correct.

**Accepted Answers:**

Statements 1 and 2 are correct, but not others.

6) For a uniaxial PML oriented in the x-direction, the value ‘a’ in the matrix

\[
\begin{pmatrix}
\frac{1}{a} & 0 & 0 \\
0 & a & 0 \\
0 & 0 & a
\end{pmatrix}
\]

depends on

- Frequency alone.
- Frequency, permittivity, and permeability.
- Frequency, permittivity, and conductivity.
- Frequency, permeability, and conductivity.

**Accepted Answers:**

Frequency, permittivity, and conductivity.

7) Which of the following statement(s) is/are true for Engquist-Majda absorbing boundary condition?

Statement 1: It is second order accurate.
Statement 2: It is first order accurate.
Statement 3: It is applicable for FDTD method but not FDFD method.
Statement 4: It is applicable for both FDTD and FDFD methods.

- Only statement 1 is correct, but not others.
- Only statement 2 is correct, but not others.
- Only statement 3 is correct, but not others.
- Only statement 4 is correct, but not others.
- Statements 1 and 3 are correct, but not others.
- Statements 2 and 3 are correct, but not others.
- Statements 2 and 4 are correct, but not others.
- Statements 1 and 4 are correct, but not others.
- None of the statements are correct.
8) For a domain with relative permeability $\mu_r$ and relative permittivity $\varepsilon_r$, truncated by PML with relative permeability $\mu_p$ and relative permittivity $\varepsilon_p$, if $\mu_r$ is halved, $\mu_p$ is doubled and $\varepsilon_r$ is doubled, the value of $\varepsilon_p$ for impedance matching at the interface of the domain and PML must be changed by

- Half
- Twice
- Four times
- Eight times
- Unchanged

Accepted Answers:

Statements 1 and 4 are correct, but not others.

9) With respect to Bérenger PML and uniaxial PML, which of the following statements is true?

- Both the PML models are based on physical models.
- Bérenger PML is based on physical model, but uniaxial PML is purely mathematical.
- Bérenger PML is purely mathematical, but uniaxial PML has a physical interpretation.
- None of the above.

Accepted Answers:

Bérenger PML is purely mathematical, but uniaxial PML has a physical interpretation.

10) The incident waves at the main domain-PML interface are not theoretically reflected because of

Statement 1: Impedance matching condition at the main domain-PML interface.
Statement 2: Decay of field components inside the PML.
Statement 3: Losses inside the PML.

- Only statement 1 is correct, but not others.
- Only statement 2 is correct, but not others.
- Only statement 3 is correct, but not others.
- Statements 1 and 2 are correct, but not 3.
- Statements 2 and 3 are correct, but not 1.
- Statements 1, and 3 correct, but not 2.
- All the statements are correct.

Accepted Answers:

Only statement 1 is correct, but not others.

11) Inside the PML, the decay of fields occurs due to

Statement 1: Impedance matching condition at the main domain-PML interface.
Statement 2: Losses inside the PML.

- Only statement 1 is correct.
- Only statement 2 is correct.
- Both the statements are correct.
- None of the statements are correct.

Accepted Answers:

Only statement 2 is correct.

12) In the case of 2D problem which one of the following figures is realistic?

(Hint: Compute reflection coefficient for first order and second truncation as discussed in the lectures.)
Acceptance Answers:
(a)