Department of Electrical and Electronics Engineering
Academic Year 2022 – 2023 (Odd Semester)

Degree, Semester & Branch: III Semester B.E. EEE
Course Code & Title: EE3301 Electromagnetic Fields
Name of the Faculty member (s): Mrs. S. Jeyanthi

Innovative Practice Description

- **Unit / Topic:** Unit I / Coordinate Systems
- **Course Outcome:** CO1
- **Topic Learning Outcome:** TLO 1
- **Activity Chosen:** Simulation
- **Justification:**

Coordinate systems are essential for studying the equations of curves using the methods of analytic geometry. To use the method of coordinate geometry, the axes are placed at a convenient position with respect to the curve under consideration. The solutions to many problems can be simplified by rotating the coordinate axes to obtain new axes through the same origin is transformation of Coordinate Systems. It is expected that; the students will have better understanding after the usage of simulation software for this topic.

Time Allotted for the Activity: 15 minutes

- **Details of the Implementation:**

The students were asked to do the transformation of Cartesian coordinate system to cylindrical and spherical coordinate systems by using the keyword cart2pol and cart2sph, cylindrical coordinate system to Cartesian coordinate systems by using the keyword pol2cart and spherical coordinate system to Cartesian coordinate systems by using the keyword sph2cart in the software tool MATLAB. Also the students were asked to convert the coordinate systems for the set of data.

CO – PO / PSO mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	1	-	-	-	-	-	-	1	1	-	-

(1 – Low 2 – Moderate 3 – High)

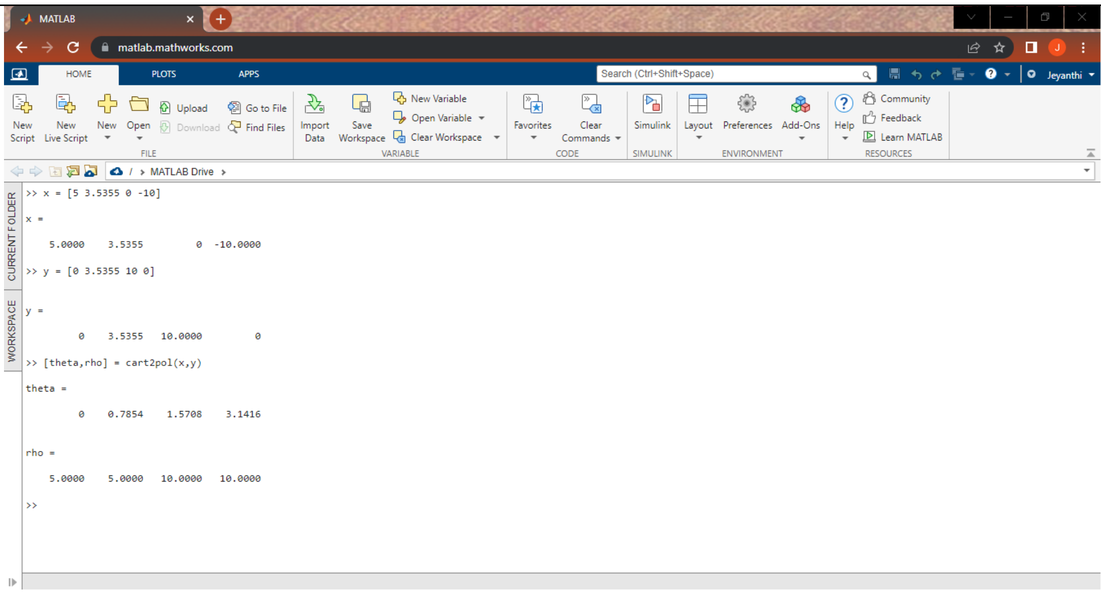
- **PO / PSO mapped:**

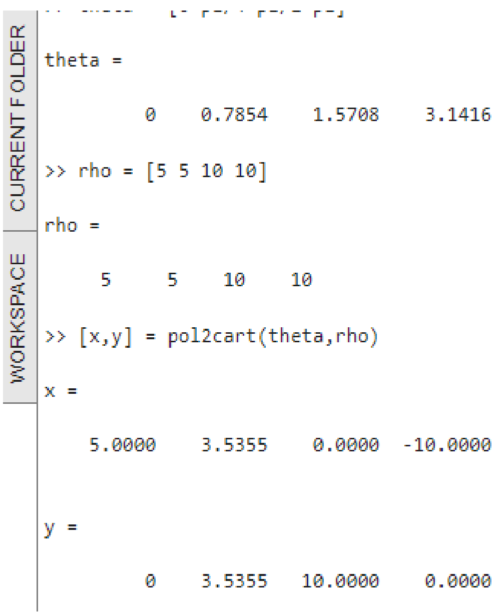
Innovative practice	**PO5**
	1
Justification for correlation	The students can effectively use the simulation software tool.

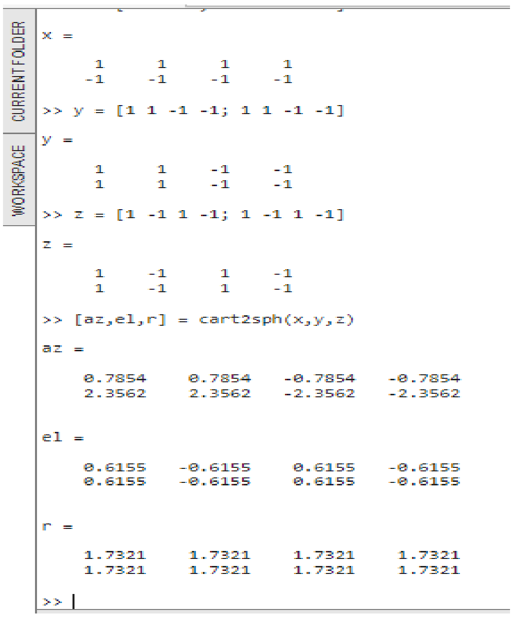
- **Images / Screenshot of the practice:**

Innovative Teaching Method Execution

Coordinate Systems – Simulation







- **Reflective Critique:**
  - ❖ ***Feedback of practice from students and other stakeholders:***
    - ✓ Students understood the concept which was reflected from their answers for the questions I have asked during discussion session.
    - ✓ Also they can able to analyse the real time problem.

  - ❖ ***Benefit of the practice:*** (E.g.: Outcome attainment would have increased due to innovative practice over conventional practice)

    The process of simulating a scenario to practice different responses and actions to a real life situation is extremely effective in knowledge retention. This is because knowledge isn't in theory – the user needs to apply it in a real-life situation. Simulations can be slowed down to study behavior more closely. Conditions can be varied and outcomes investigated. Also Critical situations can be investigated without risk.

- ***Challenges faced in implementation:***

  I planned the activity for 15 minutes. But in Class room it takes 25 minutes.

References:

1. Mathew N. O. Sadiku, 'Principles of Electromagnetics', 6th Edition, Oxford University Press Inc. Asian edition, 2015.
2. William H. Hayt and John A. Buck, 'Engineering Electromagnetics', McGraw Hill Special Indian edition, 2014.
3. Kraus and Fleish, 'Electromagnetics with Applications', McGraw Hill International Editions, Fifth Edition, 2010.

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Innovative Practice Description

- **Unit / Topic:** Unit II / Electric potential and Electric field, Equipotential plots
- **Course Outcome:** CO 2
- **Topic Learning Outcome:** TLO 6
- **Activity Chosen:** Virtual Lab
- **Justification:**

  Virtual lab refers to a virtual teaching and learning environment aimed at developing students' laboratory skills. As one of the most important eLearning tools, they allow the student to conduct various experiments without any constraints to place or time, in contrast to the constraints of real labs. By this students can visualize the electric field, electric potential, equipotential surfaces.

Time Allotted for the Activity: 15 minutes

- **Details of the Implementation:**
  The students were asked to do the following steps to understand the concept of Relationship between field and potential, relationship between the distance between the equipotential lines and the strength of the electric field.
  1. Place four charges, two positive and two negative, at four random points on a grid. Click on "Values." Drag the voltage sensor in the vicinity of the charges and click on the pencil icon. A line will appear labeled by a number.
     a) Take an electric field sensor and move it on an equipotential line. What can you say about the way magnitude and direction of the electric field changes as the sensor travels around the line?
     b) Place a few electric field sensors in a few points between the equipotential lines. Where do the electric field vectors point in terms of increase and decrease of the values on the equipotential lines?
  2. Remove the charges and place a positive charge in the center of the grid. Draw five equipotential circles with the potentials of 10 Volts, 8 Volts, 6 Volts, 4 Volts and 2 Volts. (It might be hard to get the precise values but try to get as close as you can). Take an electric field sensor and move it in a straight line, crossing the equipotential lines. Describe the relationship between the distance between the equipotential lines and the strength of the electric field.

CO – PO / PSO mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO2	3	2	-	-	1	-	-	1	-	-	-	1	1	-	-

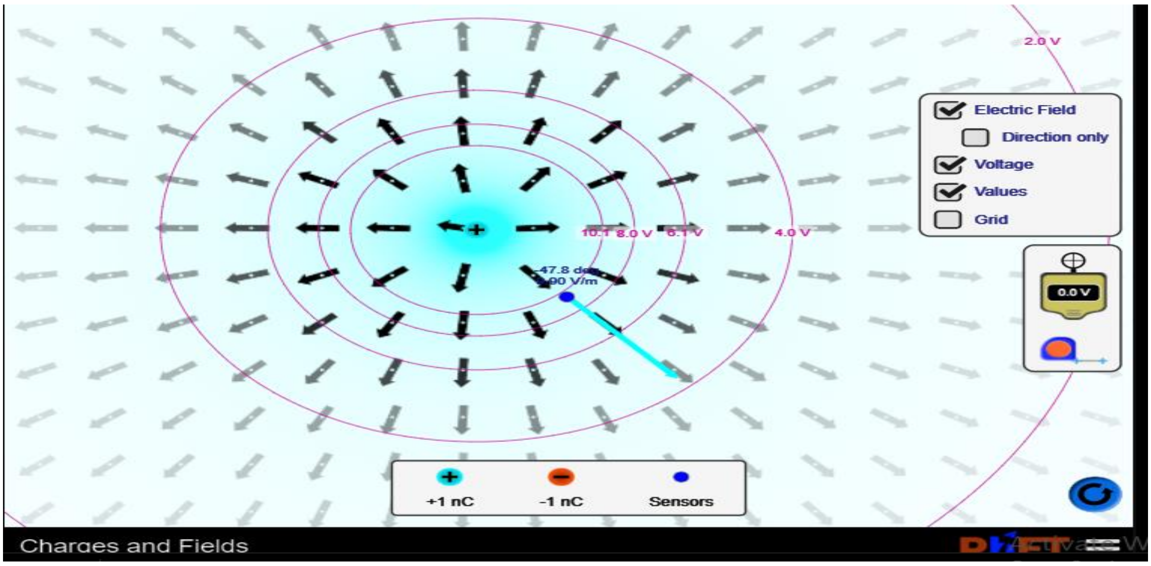
(1 – Low 2 – Moderate 3 – High)

- **PO / PSO mapped:**

Innovative practice	**PO5**
	1
Justification for correlation	The students can effectively use the virtual lab.

- **Images / Screenshot of the practice:**

Innovative Teaching Method Execution
Electric potential and Electric field, Equipotential plots – Virtual Lab



- **Reflective Critique:**
  - ❖ ***Feedback of practice from students and other stakeholders:***
    - ✓ Students understood the concept which was reflected from their answers for the questions I have asked during discussion session.
    - ✓ Also they can able to visualise the electrostatic field, therefoe they easily understand the concept.

  - ❖ ***Benefit of the practice:*** (E.g.: Outcome attainment would have increased due to innovative practice over conventional practice)

    The process of simulating a scenario to practice different responses and actions to a real life situation is extremely effective in knowledge retention. This is because knowledge isn't in theory – the user needs to apply it in a real-life situation. Simulations can be slowed down to study behavior more closely.

Conditions can be varied and outcomes investigated. Also Critical situations can be investigated without risk.

- ***Challenges faced in implementation:***

  I planned the activity for 15 minutes. But in Class room it takes 25 minutes.

References:

1. Mathew N. O. Sadiku, 'Principles of Electromagnetics', 6th Edition, Oxford University Press Inc. Asian edition, 2015.
2. William H. Hayt and John A. Buck, 'Engineering Electromagnetics', McGraw Hill Special Indian edition, 2014.
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Innovative Practice Description

- **Unit / Topic: Unit III /** Magnetic materials – Magnetization
- **Course Outcome:** CO 3
- **Topic Learning Outcome:** TLO 13
- **Activity Chosen:** Mind map
- **Justification:**

  Mind mapping is a creative way to set goals, solve problems and design action plans. It quickly records ideas in a free-form way. When groups use mini mapping, the thoughts of each participant easily trigger ideas in others. This dynamic group interaction encourages breaking free of old patterns to uncover new and innovative approaches. For this topic, there are different types of magnetic material and its characteristics can be brought in to single map for better understanding.
- **Time Allotted for the Activity:** 10 minutes
- **Details of the Implementation:**

  Mini mapping activities require students to actively engage in their learning, often by connecting their prior knowledge to new information. When creating a mini map, a student frequently interacts with a textbook, notes from class, an instructor, classmate, or study group.
- In my subject Mini map was conducted for the topic Magnetic materials – Magnetization. The students are voluntarily drawn the map.

- **CO – PO / PSO mapping:**

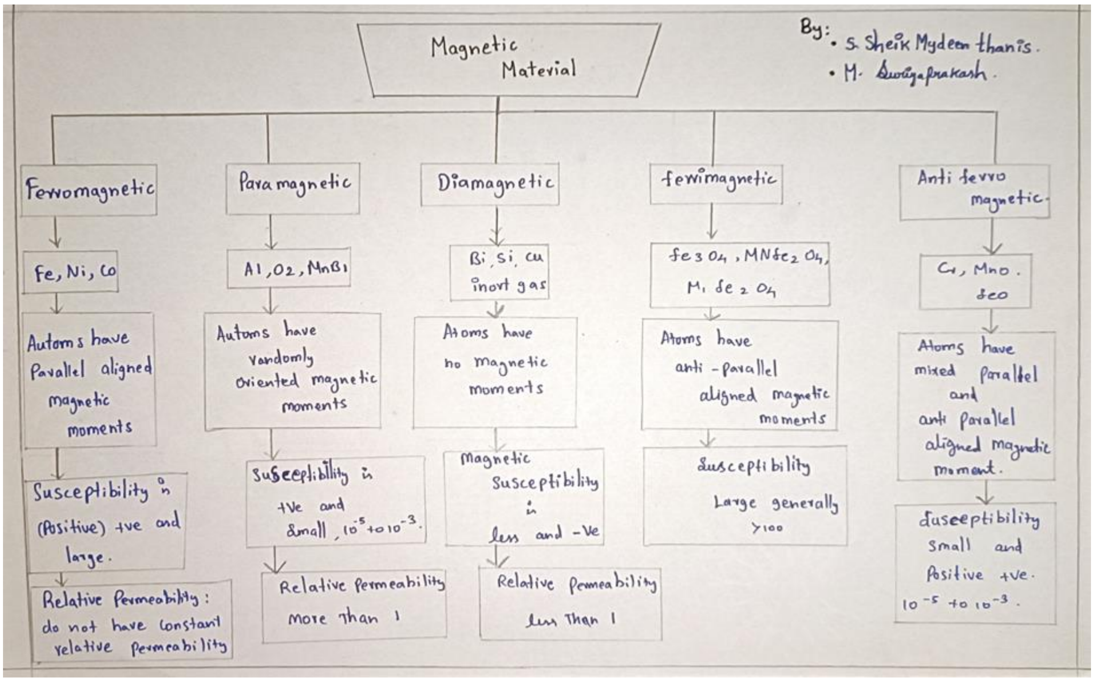
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO3	3	2	-	-	1	-	-	-	1	1	-	1	1	-	-

(1 – Low 2 – Moderate 3 – High)

- **PO / PSO mapped:**

Innovative practice	**PO9**
	1
Justification for correlation	The students can Function effectively as a team

- **Images / Screenshot of the practice:**

Innovative Teaching Method Execution
Magnetic materials – Magnetization **-** Mini map


- **Reflective Critique:**
  - ***Feedback of practice from students and other stakeholders:***

    Students understood the concept which was reflected from their answers for the questions I have asked during discussion session.

  - ***Benefit of the practice:*** (E.g.: Outcome attainment would have increased due to innovative practice over conventional practice)

    The benefits of Mini Maps are a great way for students to make notes on all of the information they receive. It helps the students to note down only the most important information using key words, and then make connections between facts and ideas visually – keeping all of your topic thoughts together on one sheet. It made key note making easier to students, as it reduces pages of notes into one single side of paper. Also mini map made slow learners to remember the information more quickly.

Challenges faced in implementation:

Normally teachers will give longer explanations in the notes section of the topic. The students are made into groups and to draw the map to Indicate relationships between the topics in biomass conversion process. I planned the activity for 10 minutes only. But in real scenario it takes 15 minutes to complete this activity.

References:

1. Mathew N. O. Sadiku, ‘Principles of Electromagnetics’, 6th Edition, Oxford University Press Inc. Asian edition, 2015.
2. William H. Hayt and John A. Buck, ‘Engineering Electromagnetics’, McGraw Hill Special Indian edition, 2014.
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Innovative Practice Description

- **Unit / Topic: Unit IV / Maxwell's equations**
- **Course Outcome:** CO 4
- **Topic Learning Outcome:** TLO 21
- **Activity Chosen:** One minute paper
- **Justification:**

  Maxwell's prediction of electromagnetic waves resulted from his formulation of a complete and symmetric theory of electricity and magnetism, known as Maxwell's equations. Since, one minute paper activity provides a conceptual bridge between successive class periods. Improve the quality of class discussion by having students write briefly about a concept or issue before they begin discussing it.
- **Time Allotted for the Activity:** 5 minutes
- **Details of the Implementation:**

  At the end of the class, students were asked to write about the topic discussed in the class. The students expressed the understood content and the content which were not clear in that particular topic. This activity shows whether the students can able to understand the specific topic and their involvement the particular class.
- **CO – PO / PSO mapping:**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO5	3	2	-	-	1	-	-	1	1	-	-	1	1	-	-

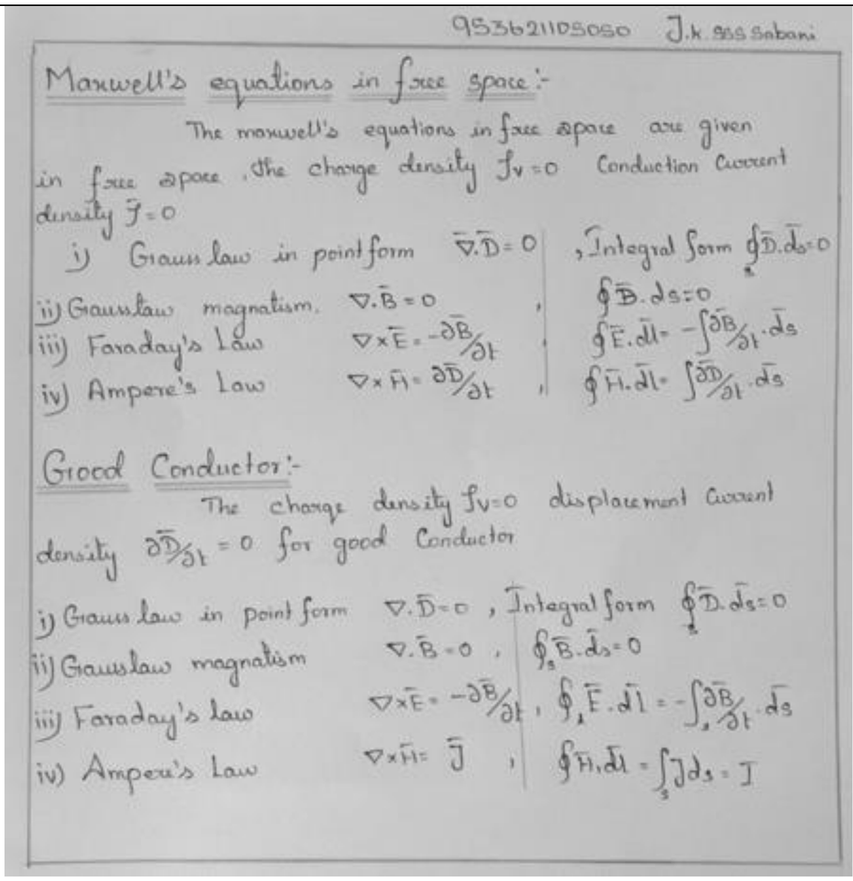
(1 – Low 2 – Moderate 3 – High)

- **PO / PSO mapped:**

Innovative practice	**PO9**
	1
Justification for correlation	The students can Function effectively as an individual

- **Images / Screenshot of the practice:**

Innovative Teaching Method Execution
Maxwell's equations - differential form – One minute paper



953621105050 J.k. sss Sabani

Maxwell's equations in free space:-

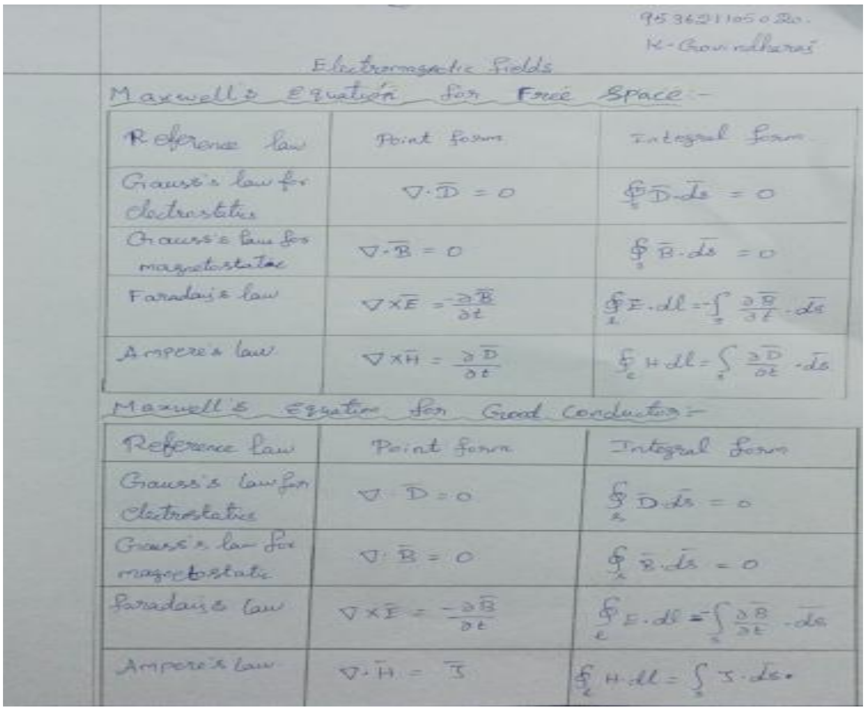
The maxwell's equations in free space are given in free space, the charge density $\rho_v = 0$ Conduction Current density $\bar{J} = 0$

i) Gauss law in point form $\bar{\nabla}.\bar{D} = 0$, Integral form $\oint \bar{D}.\bar{ds} = 0$
ii) Gausslaw magnatism. $\nabla.\bar{B} = 0$, $\oint \bar{B}.ds = 0$
iii) Faraday's Law $\nabla \times \bar{E} = -\partial \bar{B}/\partial t$, $\oint \bar{E}.\bar{dl} = -\int \partial \bar{B}/\partial t . \bar{ds}$
iv) Ampere's Law $\nabla \times \bar{H} = \partial \bar{D}/\partial t$, $\oint \bar{H}.\bar{dl} = \int \partial \bar{D}/\partial t . \bar{ds}$

Good Conductor:-

The charge density $\rho_v = 0$ displacement Current density $\partial \bar{D}/\partial t = 0$ for good Conductor

i) Gauss law in point form $\nabla.\bar{D} = 0$, Integral form $\oint \bar{D}.\bar{ds} = 0$
ii) Gausslaw magnatism $\nabla.\bar{B} = 0$, $\oint_s \bar{B}.\bar{ds} = 0$
iii) Faraday's law $\nabla \times \bar{E} = -\partial \bar{B}/\partial t$, $\oint_l \bar{E}.\bar{dl} = -\int_s \partial \bar{B}/\partial t . \bar{ds}$
iv) Ampere's Law $\nabla \times \bar{H} = \bar{J}$, $\oint \bar{H}.\bar{dl} = \int_s J ds = I$



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Electromagnetic Fields

Maxwell's Equation for Free Space:-

Reference law	Point form	Integral form
Gauss's law for electrostatics	$\nabla \cdot \bar{D} = 0$	$\oint_s \bar{D} \cdot \bar{ds} = 0$
Gauss's law for magnetostatics	$\nabla \cdot \bar{B} = 0$	$\oint_s \bar{B} \cdot \bar{ds} = 0$
Faraday's law	$\nabla \times \bar{E} = -\frac{\partial \bar{B}}{\partial t}$	$\oint_l E \cdot dl = -\int_s \frac{\partial \bar{B}}{\partial t} \cdot \bar{ds}$
Ampere's law	$\nabla \times \bar{H} = \frac{\partial \bar{D}}{\partial t}$	$\oint_c H \cdot dl = \int_s \frac{\partial \bar{D}}{\partial t} \cdot \bar{ds}$

Maxwell's Equation for Good Conductor:-

Reference law	Point form	Integral form
Gauss's law for electrostatics	$\nabla \cdot \bar{D} = 0$	$\oint_s \bar{D} \cdot \bar{ds} = 0$
Gauss's law for magnetostatic	$\nabla \cdot \bar{B} = 0$	$\oint_s \bar{B} \cdot \bar{ds} = 0$
Faraday's law	$\nabla \times \bar{E} = -\frac{\partial \bar{B}}{\partial t}$	$\oint_c E \cdot dl = -\int_s \frac{\partial \bar{B}}{\partial t} \cdot \bar{ds}$
Ampere's law	$\nabla \cdot \bar{H} = \bar{J}$	$\oint_c H \cdot dl = \int_s J \cdot \bar{ds}$

- **Reflective Critique:**
  - ***Feedback of practice from students and other stakeholders:***
    - ✓ Students understood the concept which was reflected from their answers for the questions I have asked during discussion session.

  - ***Benefit of the practice:*** (E.g.: Outcome attainment would have increased due to innovative practice over conventional practice)
    - ✓ Students can able to attend the question even in the questions are in indirect form.
    - ✓ Students can able to explain the concepts in examination without any confusion.
  - ***Challenges faced in implementation:***
    - ✓ Time utilization for conducting activity.

References:

1. Mathew N. O. Sadiku, 'Principles of Electromagnetics', 6th Edition, Oxford University Press Inc. Asian edition, 2015.
2. William H. Hayt and John A. Buck, 'Engineering Electromagnetics', McGraw Hill Special Indian edition, 2014.
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Innovative Practice Description

- **Unit / Topic: Unit V / Waves in free space, lossy dielectrics and lossless dielectrics**
- **Course Outcome:** CO 5
- **Topic Learning Outcome:** TLO 25
- **Activity Chosen:** Think pair share
- **Justification:**
  - ✓ It helps students to think individually about a topic or answer to a question.
  - ✓ It teaches students to share ideas with classmates and builds oral communication skills.
  - ✓ It helps focus attention and engage students in comprehending the reading material.
- **Time Allotted for the Activity:** 10 minutes
- **Details of the Implementation:**
  Think-Pair-Share innovative practice conducted for III year EEE students, after explained the concept of Electromagnetic waves in free space, lossy dielectrics and lossless dielectrics. First, I asked the students to think about the difference between all the above electromagnetic waves for 2 minutes. Then I make them as a pair to discuss their neighbour's and asked the students to discuss about wave parameters of the electromagnetic waves in different media for 3 minutes. Finally I asked the one of the team to explain the concept to whole class for further discussion. The students from group share their points and participated in the discussion for 10 minutes.

- **CO – PO / PSO mapping:**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO5	3	2	-	-	1	-	-	-	1	1	-	1	1	-	-

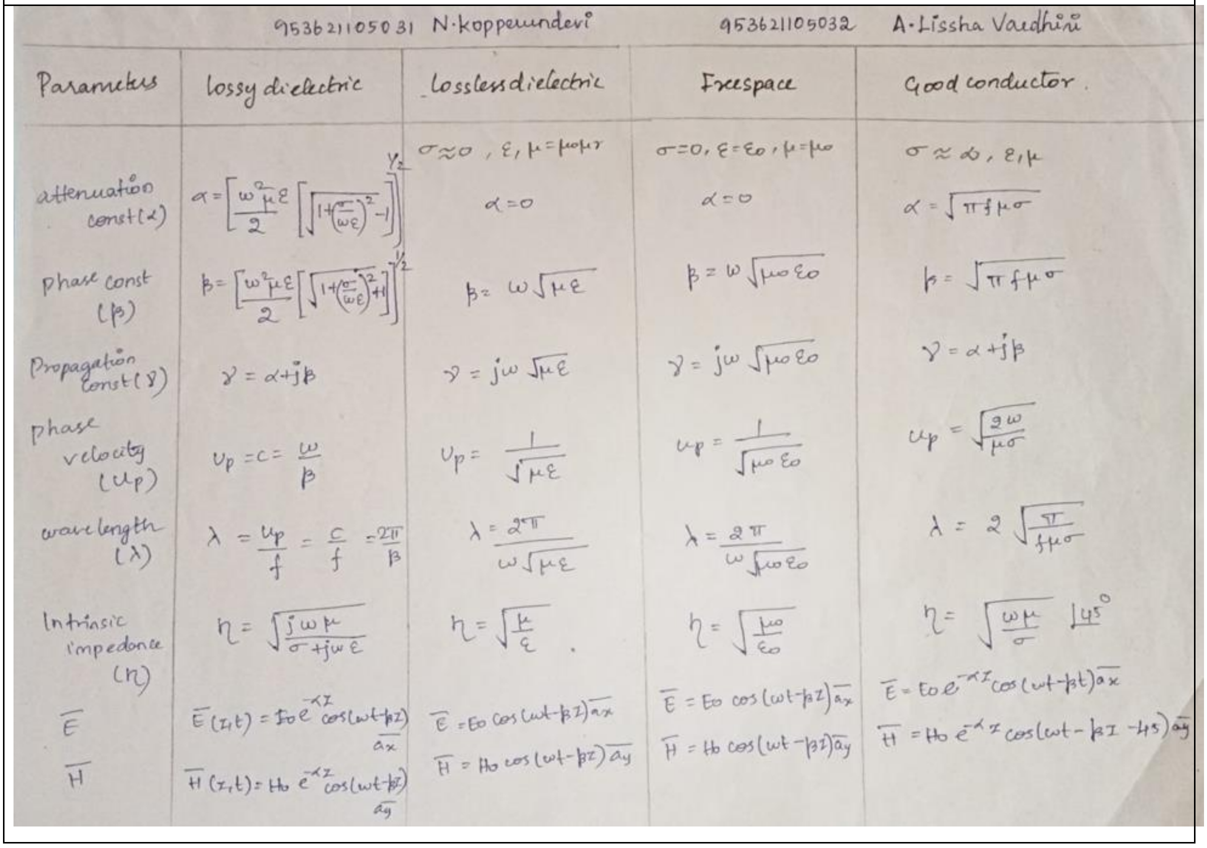
(1 – Low 2 – Moderate 3 – High)

- **PO / PSO mapped:**

Innovative practice	PO9
	1
Justification for correlation	The students can Function effectively as a team

- **Images / Screenshot of the practice:**

Innovative Teaching Method Execution
Waves in free space, lossy dielectrics and lossless dielectrics – Think Pair Share



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Parameters	lossy dielectric	Lossless dielectric	Freespace	Good conductor.
		$\sigma \approx 0$, $\varepsilon, \mu = \mu_0\mu_r$	$\sigma = 0, \varepsilon = \varepsilon_0, \mu = \mu_0$	$\sigma \approx \infty$, ε, μ
attenuation const(α)	$\alpha = \left[\frac{\omega^2\mu\varepsilon}{2}\left[\sqrt{1+\left(\frac{\sigma}{\omega\varepsilon}\right)^2}-1\right]\right]^{1/2}$	$\alpha = 0$	$\alpha = 0$	$\alpha = \sqrt{\pi f \mu \sigma}$
phase const (β)	$\beta = \left[\frac{\omega^2\mu\varepsilon}{2}\left[\sqrt{1+\left(\frac{\sigma}{\omega\varepsilon}\right)^2}+1\right]\right]^{1/2}$	$\beta = \omega\sqrt{\mu\varepsilon}$	$\beta = \omega\sqrt{\mu_0\varepsilon_0}$	$\beta = \sqrt{\pi f \mu \sigma}$
Propagation const(γ)	$\gamma = \alpha + j\beta$	$\gamma = j\omega\sqrt{\mu\varepsilon}$	$\gamma = j\omega\sqrt{\mu_0\varepsilon_0}$	$\gamma = \alpha + j\beta$
phase velocity (u_p)	$u_p = c = \frac{\omega}{\beta}$	$u_p = \frac{1}{\sqrt{\mu\varepsilon}}$	$u_p = \frac{1}{\sqrt{\mu_0\varepsilon_0}}$	$u_p = \sqrt{\frac{2\omega}{\mu\sigma}}$
wavelength (λ)	$\lambda = \frac{u_p}{f} = \frac{c}{f} = \frac{2\pi}{\beta}$	$\lambda = \frac{2\pi}{\omega\sqrt{\mu\varepsilon}}$	$\lambda = \frac{2\pi}{\omega\sqrt{\mu_0\varepsilon_0}}$	$\lambda = 2\sqrt{\frac{\pi}{f\mu\sigma}}$
Intrinsic impedance (η)	$\eta = \sqrt{\frac{j\omega\mu}{\sigma + j\omega\varepsilon}}$	$\eta = \sqrt{\frac{\mu}{\varepsilon}}$.	$\eta = \sqrt{\frac{\mu_0}{\varepsilon_0}}$	$\eta = \sqrt{\frac{\omega\mu}{\sigma}} \angle 45^\circ$
$\overline{E}$	$\overline{E}(z,t) = E_0 e^{-\alpha z}\cos(\omega t - \beta z)\overline{a_x}$	$\overline{E} = E_0\cos(\omega t - \beta z)\overline{a_x}$	$\overline{E} = E_0\cos(\omega t - \beta z)\overline{a_x}$	$\overline{E} = E_0 e^{-\alpha z}\cos(\omega t - \beta t)\overline{a_x}$
$\overline{H}$	$\overline{H}(z,t) = H_0 e^{-\alpha z}\cos(\omega t - \beta z)\overline{a_y}$	$\overline{H} = H_0\cos(\omega t - \beta z)\overline{a_y}$	$\overline{H} = H_0\cos(\omega t - \beta z)\overline{a_y}$	$\overline{H} = H_0 e^{-\alpha z}\cos(\omega t - \beta z - 45)\overline{a_y}$

- **Reflective Critique:**
  - ***Feedback of practice from students and other stakeholders:***
    - ✓ Students understood the concept which was reflected from their answers for the questions I have asked during discussion session.

  - ***Benefit of the practice:*** (E.g.: Outcome attainment would have increased due to innovative practice over conventional practice)

    Think-pair-sharing forces all students to attempt an initial response to the question, which they can then clarify and expand as they collaborate. It also gives them a chance to validate their ideas in a small group before mentioning them to the large group, which may help shy students feel more confident participating.

  - ***Challenges faced in implementation:***

    I planned the activity for 10 minutes. But in Class room it takes 15 minutes.

References:

1. Mathew N. O. Sadiku, 'Principles of Electromagnetics', 6th Edition, Oxford University Press Inc. Asian edition, 2015.
2. William H. Hayt and John A. Buck, 'Engineering Electromagnetics', McGraw Hill Special Indian edition, 2014.

3. V.V.Sarwate, 'Electromagnetic fields and waves', First Edition, Newage Publishers, 1993.
4. J.P.Tewari, 'Engineering Electromagnetics - Theory, Problems and Applications', Second Edition, Khanna Publishers.