DEPARTMENT OF PHYSICS				*CLASS: I M.Sc. Physics*				
Sem	**Course Type**	**Course Code**	**Course Title**	**Credits**	**Contact Hours/week**	**CIA**	**Ext**	**Total**
II	Major Core–6	21P2PMC6	Electromagnetic Theory	4	5	25	75	100

Nature of Course				
Knowledge and skill	✓		Employability oriented	
Skill oriented			Entrepreneurship oriented	

***Course Objectives*:**

1. To develop theoretical knowledge in electromagnetism.
2. To develop skills on solving analytical problems in electromagnetism.
3. To give basics of defining the complete electromagnetic response of complex systems.

Unit	Description	Hours	K-level	CLO
I	**Electrostatics:** Coulomb's law; the electric field – line, flux and Gauss's Law in differential form - the divergence of E - application of Gauss's law – curl of E - Poisson's equation; Laplace's equation – work and energy in electrostatics – energy of a point charge distribution – energy of continuous charge distribution – induced charges – capacitors. Potentials: Laplace equation in one dimension and two dimensions – Dielectrics – induced dipoles – Gauss's Law in the presence of dielectrics- Laplaceequation in three dimensions, Boundary condition and uniqueness theorems, conductors and the second uniqueness theorem-Electric potential, Multipole expansion, monopole and dipole, The electric field of a dipole, Linear dielectric.	**15**	Up to **K2**	**1**
II	**Magnetostatics:** Lorentz force – magnetic fields – magnetic forces – currents – Biot-Savart Law – divergence and curl of B – Ampere's Law –comparison of magnetostatics and electrostatics – Magnetic vector potential-effect of magnetic field on atomic orbit- Magnetization-Ampere's Law in magnetized materials – ferromagnetism-magnetic field of a steady current, multiple expansion of the vector potential-Boundary condition in magnetostatics.	**15**	Up to K3	2

III	**Electromotive force:** Ohm's Law – electromotive force – motional emf – Faraday's Law – induced electric field – inductance – energy in magnetic field – Maxwell's equation in matter-boundary condition- the continuity equation-Poynting theorem-Maxwell equation, magnetic charge-boundary condition in two different conducting media,Newton's third law in electrodynamics.	15	Up to K4	3
IV	**Electromagnetic waves** Waves in one dimension – wave equation – sinusoidal waves – reflection and transmission– Polarization.Electromagnetic waves in vacuum:The wave equation for E and B – Monochromatic Plan waves – energy and momentum in electromagnetic waves –propagation in linear media – reflection and transmission at normal incidence- reflection and transmission at oblique incidence-electromagnetic wave in conductors-Boundary conditions at the surface of discontinuity-Fresnel's equation -Brewster's law– Total internal reflection	15	Up to K4	4
V	**Applications of electromagnetic waves :** Wave guides–TE waves in rectangular wave guides – the co-axial transmission line- Potentials formulation: potentials and fields – scalar and vector potentials – Gauge transformation – Coulomb Gauge and Lorentz Gauge – Lorentz force law in potentialform-retarded potentials- lienard-wiechert potentials-electric dipole radiation, magnetic dipole radiation.	15	Up to K3	5

BOOK FOR STUDY:

1. Introduction to Electrodynamics – David J. Griffiths, 4th Edition, Pearson.

UNIT-I: Chapter2: 1.2,1.3,2.1,2.2,2.3,2.4,3.3,4.1,4.2,4.3,5.2,5.4.
Chapter3: 3, 1.1, 1.2, 1.3.
Chapter4: 1.1, 1.2, 3.1.
UNIT-II: Chapter5: 1.1, 1.2, 1.3, 2.1,3.1,3.2, 3.3, 4,4.1
Chapter6: 1.3, 1.4, 3.1, 4.2
UNIT-III: Chapter7:1.1,1.2,1.3,2.1,2.2,2.3,2.4,3.3,3.5,3.6.
Chapter8: 1.1, 1.2
UNIT-IV: Chapter9:1.1,1.2,1.3,1.4,2.1,2.2,2.3,3.1,3.2,3.3,4.1.
UNIT-V: Chapter9:5.1, 5.2, 5.3.
Chapter12: 1.1, 1.2, 1.3, 1.4, 2.1.

BOOKS FOR REFERENCE:

1. Electromagnetic Theory and Electrodynamics, Sathya Prakash, Kedar Nath, Ram Nath and Co,2017.
2. Electromagnetics, B.B Laud, Wiley Eastern Company,2000.
3. Fundamentals of Electromagnetic, Wazed Miah, Tata Mc Graw Hill,1980.

4. Basic Electromagnetics with Application, Narayana rao, (EEE) Prentice Hall,1997.
5. Fundamentals of Electromagnetic Theory, Third edition, Narosa Publishing House, New Delhi – John R.Reitz, Frederick J Milford and Robert W.Christy,1998.
6. Classical Electrodynamics – J.D. Jackson, II Edition, Wiley Eastern Limited,1993.
7. Electromagnetic Fields and Waves – P.Lorrain andD.Corson.
8. Electromagnetic, B.B Laud, Wiley Eastern Company,2000.

Web Resources:

1. https://en.wikipedia.org/wiki/Gauss%27s_law
2. https://eng.libretexts.org/Bookshelves/Electrical_Engineering/Electro-Optics/Book%3A_Electromagnetics_I_(Ellingson)/05%3A_Electrostatics/5.15%3A_Poisson%E2%80%99s_and_Laplace%E2%80%99s_Equations
3. https://getmyuni.azureedge.net/assets/main/study-material/notes/electronics-communication_engineering_electromagnetic-field-theory_poisson-s-and-laplace-equation_notes.pdf
4. http://www.maths.dur.ac.uk/~dma0sfr/EM/Handouts/EMnotes-epiphany.pdf
5. https://en.wikipedia.org/wiki/Biot%E2%80%93Savart_law
6. https://www2.ph.ed.ac.uk/~mevans/em/lec8.pdf
7. https://en.wikipedia.org/wiki/Maxwell%27s_equations
8. http://www.phys.virginia.edu/classes/109N/more_stuff/Maxwell_Eq.html
9. https://mdashf.org/2018/11/01/boundary-conditions-on-electric-and-magnetic-fields/
10. http://www.phys.nthu.edu.tw/~thschang/notes/EM09.pdf
11. http://indico.ictp.it/event/7592/session/6/contribution/23/material/slides/0.pptx
12. http://web.mit.edu/8.02t/www/802TEAL3D/visualizations/coursenotes/modules/guide13.pdf
13. http://www.physics.sfsu.edu/~lea/courses/ugrad/460notes5.PDF
14. https://www.mdpi.com/2079-9292/9/5/808/pdf
15. https://www.elprocus.com/electromagnetic-spectrum-em-spectrum-working-its-applications/

Rationale for Nature of the course

The course is the learning of essential basis for understanding the theoretical methods and system used for electrical energy and power relies on key concepts from electromagnetic theory.

Activities having direct bearing on skill development/Employability / Entrepreneurship

The test of all knowledge is theoretical results are illustrated by matching the experimental data in the activities and uses of electromagnetic theory.

Pedagogy: Chalk and talk , materials, PPT, Quiz , Assignment , Seminar , Problem solving , Group discussion , interaction and field visit.

Course Designers:

Dr.M.Kavitha

Lecture Schedule

Unit	Topics	Hrs	Mode
Unit I	Coulomb's law; the electric field , line, flux and Gauss's Law in differential form	2	PPT, Chalk and talk, Quiz and assignment
	The divergence of E ,application of Gauss's law, curl of E, Poisson's equation; Laplace's equation	3	
	work and energy in electrostatics, energy of a point charge distribution, energy of continuous charge distribution, induced charges	4	
	Laplace equation in one dimension and two dimensions, Dielectrics, induced dipoles, Gauss's Law in the presence of dielectrics.	4	
	Electric potential, Multipole expansion, monopole and dipole	2	
Unit II	Lorentz force – magnetic fields – magnetic forces – currents – Biot-Savart Law	4	Chalk and talk, Quiz and assignment
	Divergence and curl of B ,Ampere's Law ,comparison of magnetostatics and electrostatics	4	
	Magnetic vector potential-effect of magnetic field on atomic orbit	2	
	Magnetization-Ampere's Law in magnetized materials – ferromagnetism.	3	
	magnetic field of a steady current, multiple expansion of the vector potential.	2	
Unit III	Ohm's Law , electromotive force, motional emf , Faraday's Law	3	Chalk and talk, Quiz, assignment and seminar
	Induced electric field , inductance, energy in magnetic field, Maxwell's equation in matter-boundary condition	4	
	The continuity equation, Poynting theorem.	2	
	Maxwell equation, magnetic charge.	2	
	Boundary condition in two different conducting media,Newton's third law in electrodynamics.	4	
Unit IV	Waves in one dimension , wave equation , sinusoidal waves , reflection and transmission	4	Chalk and talk, quiz, Group discussion
	Electromagnetic waves in vacuum:The wave equation for E and B – Monochromatic Plan waves	2	
	energy and momentum in electromagnetic waves –propagation in linear media	3	
	reflection and transmission at normal incidence- reflection and transmission at oblique incidence	4	
	electromagnetic wave in conductors, Boundary conditions at the surface of discontinuity	2	
Unit V	Wave guides–TE waves in rectangular wave guides, the co-axial transmission line	4	PPT, Chalk and talk, Quiz and Interaction
	Potentialsformulation: potentials and fields, scalar	2	
	vector potentials and Gauge transformation	3	
	Coulomb Gauge and Lorentz Gauge , Lorentz force law in potentialform,retarded potentials.	4	
	lienard-wiechert potentials, electric dipole radiation	2	

Course Learning Outcomes: On the successful completion of the course, students will be able to

CLOs	Course Learning Outcomes	Knowledge Level
CLO 1	Apply mathematical operations and develop knowledge of vector fields and scalar fields	Up to K2
CLO 2	Explain boundary value problem in electrostatics and magneto statics	Up to K3
CLO 3	Acquire knowledge on the information of the various mode of propagation in Maxwell equations	Up to K4
CLO 4	Analyses the behavior of EM wave in conducting media	Up to K4
CLO 5	categorize with the basis of radiation and radiation reaction	Up to K3

Mapping of CLOs with PSOs

#	PSO1	PSO2	PSO3	PSO4	PSO5
CLO1	3		2	2	2
CLO2	3	2	3	3	
CLO3	3	2	3	2	2
CLO4	3	2	2	2	
CLO5	3		2	2	2

Advance application –3, Intermediate level –2 , Basic level–1

Learning Outcome Based Education (LOBE) & Assessment
Summative Examination – Blue Print
Articulation Mapping-K Levels with Courses Learning Outcomes (CLOs)

Units	CLOs	K- Level	Section A		Section B		Section C (Either/or Choice)	Section D (Open Choice)
			MCQs		Short Answers			
			No. of Questions	K- Level	No. of Questions	K- Level		
1	CLO 1	Up to K2	2	K2 & K2	1	K3	2 (K3&K3)	1 (K2)
2	CLO 2	Up to K3	2	K2 & K3	1	K2	2 (K2&K2)	1 (K3)
3	CLO 3	Up to K4	2	K3 & K4	1	K3	2 (K4&K4)	1 (K4)
4	CLO 4	Up to K4	2	K3 & K4	1	K3	2 (K4&K4)	1 (K4)
5	CLO 5	Up to K3	2	K2 & K3	1	K2	2 (K3&K3)	1 (K3)
No. of Questions to be asked			10			5	10	5
No. of Questions to be answered			10			5	5	3
Marks for each question			1			2	5	10
Total Marks for each section			10			10	25	30

Distribution of Section-wise Marks with K Levels

K Levels	Section A (No Choice)	Section B (No Choice)	Section C (Either/or)	Section D (Open Choice)	Total Marks	% of Marks without choice
K1	2	4	10	-	**16**	13.33
K2	2	4	10	10	**26**	21.67
K3	4	2	10	20	**36**	30.00
K4	2	-	20	20	**42**	35.00
Total Marks	10	10	50	50	**120**	100.00