MUZAFFARPUR INSTITUTE OF TECHNOLOGY Muzaffarpur

COURSE FILE

of

Advanced Electromagnetic Field (041709)

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VISION OF DEPARTMENT

The department is committed for high quality teaching and pursuit of excellence in research. We pledge to serve the nation and society by providing skilled and well developed human resource through brilliance in technical education and research..

MISSION OF DEPARTMENT

- To encourage innovation and research through projects and developmental activities with industries, institutions and government.
- To inculcate moral and ethical values with a sense of competitiveness, self-confidence and sincerity among the students to make them a good human and a good citizen.
- To produce excellent engineers, innovators, entrepreneurs and academicians for the growth of the society.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

After successful completion of program, graduates will be able to

PEO1: work in the infrastructure development projects.

PEO2: pursue higher studies.

PEO3: contribute in teaching, research and other developmental activities of electronics & communication engineering and its allied fields.

PEO4: work in the multicultural and multidisciplinary groups for the sustainable development and growth of electronics and communication engineering projects and profession.

PROGRAMME OUTCOMES (PO):

PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental

	considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of and need for sustainable development.
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

COURSE OBJECTIVES AND COURSE OUTCOMES:

Institute/college Name	MuzaffarpurInstitute of Technology, Muzaffarpur
Program Name	B.Tech. (ECE – 7th semester)
Course Code/course credits	041709 (4)
Course Name	Advanced Electromagnetic field
Lecture/ Sessional (per week)	3-1-0

Course objective:

This course is designed for the 7th semester UG students of ECE. This course's objective is to introduce the student to antennas, covering their principles of radiation, their basic parameters, (radiation resistance, radiation pattern, polarization, reciprocity, effective radiated power), their general types, and those commonly used in wireless systems. The student learns how to quickly analyse a communication link that uses standard antennas and suffers from the various effects of propagation. The course reviews Electromagnetic Theory and electromagnetic wave properties.

Course outcomes (CO):

After completion of the course, a student would be acquainted with the following:

CO1: Understand the behaviour of electromagnetic wave propagation in different waveguide.
CO2: Understanding the basic principles and radiation of antennas.
CO3: Recognizing fundamental parameters of antennas.
CO4:Undertanding the means of propagation of Electromagnetic wave i.e. free space propagation and also about frequency dependent layer selection.
CO5: Understand the performance of fundamental antennas like Yagi-Uda, Horn antennas and Helical structure and also their operation methodology in practice.

MAPPING OF COs AND POs

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Correlation level: 1- slight (Low) 2- moderate (Medium) 3-substantial (High)

COURSE SYLLABUS:

Guided waves & wave guide: Waves between parallel planes. TM & TE waves, Their propagation attenuation in parallel plane guides, Rectangular wave guides – TE & TM waves in rectangular guides, Wave impedance, Circular wave guides, Introduction to resonators.

Electromagnetic Radiation: Potential function & electromagnetic fields, a small current element radiation, Power radiated by current element & radiation resistance, Radiation from quarter wave monopole & half wave dipole.

Antenna: Fundamental parameters of antenna, network theorem, two element array, linear array, multiplication of patterns, binomial array.

Directional properties and Gain terminal impedance: Types of antenna – mutual impedance of antenna, travelling wave antenna, rhombic antenna, Yagi antenna.

Propagation of EMF waves, various paths, space waves, surface waves & propagation along spherical earth. propagation, mechanisms of tropospheric wave propagation, duct and super – refraction.

Nature and properties of ionosphere : Critical frequency, MUF, effect of geo – bar magnet, solar activity, and fading of ionospheric waves.

GATE Syllabus: Waveguides: modes, boundary conditions, cut-off frequencies, dispersion relations; Antennas: antenna types, radiation pattern, gain and directivity, return loss, antenna arrays

MUZAFFARPUR INSTITUTE OF TECHNOLOGY

B.Tech. 7th Semester (2015 Batch) w.e.f. 10.07.2018

DAY	I (9-10.00AM)	II (10.00-11.00AM)	III (11.00-12.00PM)	IV (12.00-01.00PM)		V (02.00-3.00PM)	VI (3.00-4.00PM)	VII (4.00-5.00PM)
MON					RECESS			
TUE								
WED			AET (RAK)EB3					
THU			AET (RAK)EB3					
FRI				AET(T2) (RAK)EB2				
SAT	AET (RAK)EB3		AET(T1) (RAK)EB3					

Asst. Prof-in-charge (TT) **Prof.-in-charge (TT)** **Principal**

STUDENTS' LIST:

1	15EC01	ASHISH KUMAR JHA
2	15EC02	ABHISHEK KUMAR
3	15EC03	ASHWANI JYOTI
4	15EC04	PRIYANKA KUMARI
5	13EC05	RANJEET KUMAR
6	15EC06	SUMBUL AFREEN
7	15EC07	PINKIKUMARI
8	15EC08	SAURAV KUMAR
9	15EC09	ANAMIKA RAJ
10	15EC10	SWEETY KUMARI CHAUDHARY
11	15EC11	ROHIT KUMAR
12	15EC12	RAUSHAN KUMAR
13	15EC13	ANOOP PATEL
14	15EC17	PUSHPAM BHARTI
15	15EC18	KARUNA KESHAR
16	15EC19	SATYAM KESHARI
17	15EC20	AMRITA KUMARI
18	15EC23	RANJAN KUMAR
19	15EC24	RAUSHAN KUMAR GUPTA
20	15EC25	UDAY SHANKAR KUMAR
21	15EC27	SHIVAM KUMAR
22	15EC28	AASHISH KARN
23	15EC29	HIMANSHU KUMAR
24	15EC30	CHANDA KUMARI
25	15EC32	VIKRAM KUMAR
26	15EC35	SUJEET KUMAR PANDIT
27	15EC36	RAVI PRATAP
28	15EC37	ABHIJEET ARYAN
29	15EC38	MD ISLAM
30	15EC39	RAHUL RAJ
31	15EC40	DEEPAK KUMAR
32	15EC41	SNEHI KUMARI
33	15EC42	AMIT KUMAR
34	15EC46	VIJETA
35	15EC47	HASMAIN KASHMI
36	16(LE)EC01	BAISHALI CHOUDHARY
37	16(LE)EC02	CHIRANJEEV KUMAR GUPTA

COURSE PLAN

Topic No.	Topic	No. of Lecture/ lecture no.	Text book
1.	**Waveguide**	**15**	TB1
	Introduction to waveguide and different types waveguide	1-2	
	Transverse electric modes in Rectangular waveguide	3	
	Transverse magnetic modes in Rectangular waveguide	4	
	Dominant, evanescent mode and wave impedance	5	
	Wave propagation in the guide	6	
	Power transmission and attenuation in the guide.	7	
	Waveguide current and mode excitation.	8	
	Transverse electric modes in circular waveguide	9	
	Transverse magnetic modes in Rectangular waveguide	10	
	Introduction to waveguide resonators.	11-12	
	Transverse electric and magnetic modes in waveguide resonators.	13-15	
	ASSIGNMENT-1		
2.	**Radiation**	**9**	TB2, TB3
	Introduction to Antenna Radiation.	16	
	The vector potential function 'A' for an electric current source.	17	
	The vector potential function 'F' for a magnetic current source.	18	
	Solution of the vector potential wave equation.	19	
	Near and Far field radiation	20	
	Power radiated by current element and their radiation resistance	21	
	Radiation from half wave dipole antenna.	22-23	
	Radiation from quarter wave monopole.	24	

	ASSIGNMENT-2		
3.	**Fundamental parameters of antenna and Antenna array**	**9**	TB2, TB3
	Radiation pattern of antenna	25	
	Radiation power density and radiation intensity of antenna.	26	
	Antenna Directivity, antenna gain and antenna efficiency.	27	
	Half power beamwidth, beam efficiency and antenna polarization.	28-29	
	Introduction to antenna array(two element array).	30	
	Radiation pattern of two element array.	31	
	N- element array and multiplication pattern.	32-33	
	Mid semester exam		
4.	**Types of Antenna**	**3**	TB2, TB3
	Mutual impedance of antenna, Travelling wave antenna.	34	
	Rhombic and Yagi-Uda antenna.	35-36	
	ASSIGNMENT-3		
5.	**Propagation of EMF waves**	**6**	TB3
	Introduction to Propagation of EMF wave	37	
	Different modes of wave propagation.	38	
	Ground wave propagation, plane earth reflection.	39	
	Earth behavior at different frequencies and curved earth reflection.	40	
	Space wave, limitations of Ground and Sky wave.	41	
	Effects of curvature of earth.	42	
6.	**Nature and properties of ionosphere**	**7**	TB3
	Mechanism of tropospheric	43	

	wave propagation		
	Duct and super refraction	44	
	Wave propagation mechanism in Ionosphere	45	
	Reflection and refraction of sky wave by ionosphere.	46	
	Relation between MUF and Skip distance.	47	
	Impact of solar activity on wave propagation, fading	48	
	Multi-Hop propagation and Take off angle	49	
	Assignment-4		
Total Number of Lecture		49	

Text Books:

TB1: Principles of Electromagnetics by Mathew N.O. Sadiku, Oxford.
TB2: Antenna theory by C.A. Balanis , Willey.
TB3: Antenna and Wave propagation, J.D.Kraus, R.J. Marhefka, McGraw Hill.

Reference Book:

RB1: Electromagnetic waves and radiating systems by Jordan & Balmain, PHI.

DETAILS OF ASSIGNMENTS:

S.No.	Assignment	Topic No.
1	Assignment 1	1
2	Assignment 2	2
3	Assignment 3	3,4
4	Assignment 4	5,6

ASSIGNMENT-1

1. A rectangular waveguide with dimensions a = 2.5 cm, b = 1 cm is to operate below 15.1 GHz. The no. of TE mode that can be possible if the guide is filled with a medium characterized by σ = 0, ε= $4\varepsilon_0$,μ_r = 1?

2. In a rectangular waveguide for which a = 1.5 cm, b = 0.8 cm, σ = 0, ε= $4\varepsilon_0$,μ_r = 1 ,Hx = 2 sin(πx/a)cos (3πy/b) sin(π*$10^{11}t$−βz) A/m The mode of operation is

3. In the above question the value of cutoff frequency, phase constant β and Wave impedance are

4. An air-filled rectangular waveguide has cross-sectional dimensions a = 6 cm and b = 3 cm. Given that
Ez = 5 sin(2πx/a)sin (3πy/b) cos($10^{12}t$−βz) A/m the intrinsic impedance of this mode and the average power flow in the guide are

5. A 1-cm X 3-cm rectangular air-filled waveguide operates in the TE_{12} mode at a frequency that is 20% higher than the cutoff frequency. the operating frequency , phase and group velocities are

6. In a rectangular waveguide for which $a = 2b$, the cutoff frequency for TE_{12} mode is 12 GHz, the cutoff frequency for TM_{11} mode is
(a)3 GHz (b) 3√5GHz (c) 12 GHz (d) 6√5GHz

7. For TE_{30} mode, which of the following field components exist?
(a) Ex (b) Ey (c) Ez (d) Hy

8. An air filled cubical cavity of size 10cm has $E = 200\sin(30\pi x)\sin(30\pi y)\cos(6*10^9 t)\,a_z\,V/m$
(a) Find H. (b) show that E.H=0

9. An air filled cavity has dimensions 20mm X 8mm X 10mm. If the walls are silver plated, find (a) dominant frequency (b) Q for the TE_{101} mode.

10. find the cutoff frequencies of the first two propagating modes of a circular waveguide with dielectric constant 2.08 and radius is 0.5cm.

11. For the dominant mode of operation in an air filled circular waveguide if inner diameter 4cms, find (a) cutoff wavelength (b) cutoff frequency (c) wavelength in the guide.

12. calculate the breakdown power of an air filled rectangular waveguide of size 2.3cm X 1cm for dominant mode at 9.375 GHz.