GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: MICROWAVE & RADAR ENGINEERING
(COURSE CODE: 3351103)

Diploma Programme in which this course is offered	Semester in which offered
Electronics and communication Engineering	5th Semester

1. RATIONALE

The knowledge of microwave devices is essential for electronics and communication engineering diploma holders and they need to assimilate it in order to maintain Microwave devices used in Telecommunication Industry. Hence, the basic knowledge of microwave signal generation, propagation, amplification and measurement is vital. This course has been designed to achieve the diploma engineer will maintain microwave devices, components and accessories used in telecommunication industry.

2. LIST OF COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

- **Install and Maintain microwave devices, components and accessories used in telecommunication field.**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Distinguish Electromagnetic wave propagation through reflections from voltage and current transmission.
ii. Analyze performance of microwave components from field point of view.
iii. Maintain microwave components and Set up of microwave bench for optimum operation.
iv. Maintain microwave semiconductor devices used to realized amplifiers and oscillators.
v. Maintain RADAR system as microwave application.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	150
4	0	2	6	70	30	20	30	

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment

5. COURSE DETAILS

Unit	Major Learning Outcomes (Major outcomes in cognitive domain)	Topics and Sub-topics
Unit – I. Transmission lines and Microwaves	1a. Describe EM wave frequency bands and spectrum 1b. State the strengths and limitations of microwave communication	1.1 Microwaves: frequency band, EM waves, General applications of microwaves
	1c. Explain the equivalent circuit of a two wire transmission line. 1d. Obtain the general equation for a two wire transmission line. 1e. State characteristics of lossless transmission line. 1f. Explain impedance matching using stub 1g. Using design equations solve example of single stub matching	1.2 Transmission lines: Parameters, general line equation, lossless line, λ/4 line, standing waves , VSWR, reflection coefficient ,stub matching (single and double) , skin effect
Unit– II Microwave Propagation and Components	2a. Describe propagation of microwaves through waveguide and explain cutoff wavelength. 2b. Differentiate between transmission line and waveguide. 2c. Calculate cut off wavelength, group and phase velocities, characteristics wave impedance of any waveguide parameters.	2.1 Waveguides: Wave propagation through guided medium, reflections of waves
	2d. Distinguish the following: cut off wavelength, group and phase velocities, characteristics wave impedance, TE, TM modes, S Parameters.	2.1 Rectangular waveguide : structure , cut off wavelength , group and phase velocities, characteristic wave impedance , TE ,TM modes , field patterns , examples, S Parameters basics
	2e. Compare the working of rectangular waveguide and circular waveguide.	2.2 Circular waveguide: structure, cut off wavelength, modes, examples, comparison with rectangular waveguide
	2f. State applications of following microwave components: Tees, hybrid ring , directional coupler , Duplexer , isolator ,circulator , cavity resonators 2g. Differentiate E-Plane Tee, H-Plane Tee and magic Tee. 2h. Explain the working of directional coupler, isolator and circulator with	2.3 Microwave Components: Tees, hybrid ring , directional coupler , Duplexer , isolator , circulator , cavity resonators

Unit	Major Learning Outcomes (Major outcomes in cognitive domain)	Topics and Sub-topics
	sketches. 2i. Explain working of cavity resonators with sketches.	
	2j. Describe working of bends, corner, and twist taper with sketches.	2.4 Microwave Accessories: corners and bends , twist and taper
Unit– III Microwave tubes and measurements	3a. Describe the frequency limitation of vacuum tubes at microwave frequency.	3.1 Limitations of vacuum tubes at microwave frequency
	3b. Explain function of reflex klystron with the help apple gate diagram. 3c. Explain structure and effects of various fields' acts on electron moving in the magnetron tube. 3d. Describe working of Travelling Wave Tube as an amplifier. 3e. Explain π mode oscillation and define frequency pushing and pulling. 3f. Explain two cavity klystron with apple gate diagram. 3g. Describe working of Backward Wave Oscillator.	3.2 Microwave tubes amplifiers: Klystron - Two cavity and multi cavity, Travelling Wave Tube 3.3 Microwave tubes oscillators: Reflex klystron, Magnetron, Backward Wave Oscillator
	3h. Explain microwave power measurement methods. 3i. Explain significance of VSWR measurement. 3j. Explain attenuation measurement methods. 3k. Describe Q measurement technique.	3.4 Microwave measurement: power, frequency, wavelength (free space, guided and cutoff), VSWR, attenuation, 'Q'.
	3l. Explain hazards due to microwave radiation.	3.5 Microwave radiation hazards: types (HERP, HERO, HERF), and protection from hazards

Unit	Major Learning Outcomes (Major outcomes in cognitive domain)	Topics and Sub-topics
Unit–IV Microwave semiconductor devices	4a. Explain varactor diode's working with diagrams. 4b. Describe transfer electron effect using the energy level diagram for GUNN diode. 4c. Explain the working of GUNN diode as an oscillator. 4d. Explain principle, construction, working and application of TUNNEL diode 4e. Explain the working of a PIN diode as a switch. 4f. Explain the negative resistance principle for IMPATT/TRAPATT diode with sketches.	4.1 Microwave diodes: VARACTOR diode , GUNN diode, TUNNEL, PIN diode, IMPATT diode, TRAPATT diode
	4g. Explain the parametric amplifier with diagrams. 4h. Explain the frequency up and down conversion concepts for parametric amplifier	4.2 Parametric amplifier 4.3 High electron mobility transistors
	4i. Explain the concept of high electron mobility transistor / strip line and micro strip circuits in brief.	4.4 Strip line and micro strip circuits
	4j. Describe working of RUBY MASER.	4.5 MASER: working principle, solid state RUBY MASER
Unit-V RADAR systems	5a. Explain basic principle of radar and sonar.	5.1 Introduction: Basic principle of Radar and Sonar
	5b. Using given data for RADAR calculate the radar range /minimum received power / operating frequency range. 5c. Obtain the equation for maximum RADAR range. 5d. Using radar range equation describes how the parameters affect the maximum range.	5.2 Radar range equation and examples, factors affecting maximum range.
	5e. Explain scanning and tracking methods used in radar communication. 5f. Explain the working of pulsed radar with the help of block diagram. 5g. Describe display methods used for RADAR.	5.3 Pulse radar: block diagram, radar antenna and scanning and tracking methods, Display methods

Unit	Major Learning Outcomes (Major outcomes in cognitive domain)	Topics and Sub-topics
	5h. Explain the principle of CW Doppler radar and define blind speed. 5i. Describe the working of MTI radar with the help of suitable sketch. 5j. Explain how the CW radar used for range measurement. 5k. Compare the pulsed radar and CW radar.	5.4 CW Doppler radar: Moving target indicator radar, blind speed, Frequency modulated CW radar. RADAR applications.

6. SUGGESTED SPECIFICATION TABLE WITH HOURS AND MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Transmission lines and Microwaves	08	03	03	04	10
II	Microwave propagation and components	14	08	06	04	18
III	Microwave tubes and measurement	14	08	06	04	18
IV	Microwave semiconductor devices	12	02	06	04	12
V	RADAR systems	08	04	02	06	12
	Total	**56**	**25**	**23**	**22**	**70**

Legends: R = Remember U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills ***(outcomes in psychomotor and affective domain)*** so that students are able to acquire the competencies/course outcomes. Following is the list of practical exercises for guidance.

Note*: outcomes in psychomotor domain are listed here as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes (****as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S.No.	Unit No.	Practical Exercises (Major outcomes in Psychomotor Domain)	Approx Hrs. Required
1	I	Measure open circuit & short circuit parameters for the given length of Transmission line.	02
2	I	Measure VSWR & reflection coefficient for given length of transmission line.	02
3	II	Set the microwave bench for optimum frequency operation	02
4	II	Measure the voltage maxima and minima on slotted waveguide and calculate free space, cut off and guided wavelength.	02
5	II	Identify various microwave components in the microwave circuit.	02
6	II	Determine the directivity, insertion loss , and coupling factor for a given directional coupler.	02
7	II	Determine the isolation factor for a given isolator.	02
8	II	Determine the coupling factor and, insertion loss, for a given circulator.	02
9	II	Calibrate the given variable attenuator.	02
10	III	Measure microwave frequency using the given (direct and /or indirect) frequency meter.	02
11	III	Measure VSWR for given microwave loads.	
12	III	Measure attenuation of given attenuator.	02
13	IV	Test different controls and functions of GUNN / KLYSTRON power supply.	
14	IV	Determine the characteristic of microwave crystal diode.	02
15	IV	Test the performance of TUNNEL diode	02
16	V	Investigate the fundamental concepts of Doppler radar	02
17	V	Setup radar kit and tune it for best performance.	02
18	V	Measure speed of a fan using RADAR kit.	02
19	V	Measure the variable speeds of moving objects using Velocity simulator	02
20	V	Measure the speed of a moving object with Doppler radar from different angles.	02
21	V	Calculate the speed of a moving object approaching or receding away from radar from different-different angles	02
22	V	Estimate the size of a moving objects using Radar.	02
23	V	Measure the distance traveled by any object using Radar	02
Total Hours			**46**

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities such as:

i. Prepare chart showing various microwave components.
ii. Prepare/Download a dynamic animation to illustrate the following:
    a. Microwave tubes.
    b. EM waves propagation.
iii. Visit a place where waveguides are used for microwave communication. (Such as airport, earth station, Telephone exchange, Microwave link repeater, TV broadcast).

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Show video/animation films or Power point presentation to explain functioning of various microwave components and Microwave tubes.

10. SUGGESTED LEARNING RESOURCES

A) List of Books

S.No.	Title of Books	Author	Publication
1.	Microwave Engineering	Gupta Sanjeev	Khanna Publication, New Delhi (Latest edition)
2.	Electronics communication system	Kennedy George	Tata McGraw hill, New Delhi (Latest edition)
3.	Microwave engineering	Das Annapurna & Das S. K.	Mc. Graw Hill, New Delhi, (Latest edition)
4.	Microwave Devices & Circuits	Liao Samuel Y.	PHI Learning, New Delhi, (Latest edition)
5.	Microwave & RADAR Engineering	Gautam A. K.	S K Kataria Publications, New Delhi, (Latest edition)

B) List of Major Equipment/ Instrument with Broad Specifications

i.	Transmission line trainer.	
ii.	Gunn / klystron power supply	‘X’ band
iii.	VSWR meter	Resonated at 01 KHZ
iv.	Microwave bench(Gunn / klystron)	‘X’ band component.
v.	Microwave accessories	BNC to BNC cables, Main Chords.
vi.	Microwave components	‘X’ band
vii.	Radar trainer kit	Microwave X band frequency range

C) List of Software/Learning Websites

i. RF Tool box: MATLAB & SIMULINK:
ii. http://www.rf-mw.org/transmission_lines_and_distributed_systems_transmission_lines_transmission_lines.html
iii. http://www.rf-mw.org/transmission_lines_and_distributed_systems_transmission_lines_transmission_lines_video_lectures.html
iv. www.nptel.ac.in

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. M. N. Charel,** HOD (EC), Government polytechnic, Ahmedabad
- **Prof. K. R. Vadalia,** Sr. Lecturer (EC), Govt. Polytechnic, Rajkot.
- **Prof. K. R. Shah,** Sr. Lecturer (EC), Govt. Polytechnic, Patan.
- **Prof. R. G. Patankar,** Lecturer (EC), Government polytechnic, Gandhinagar.
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- **Prof. (Dr.) (Mrs.) Anjali Potnis,** DEEE,NITTTR, Bhopal