# MICROWAVE ENGINEERING

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| **IV B. Tech -I Semester** | | | | |
| **Course Code:A3EC40** | **4** | **1** | **-** | **4** |

**Course Overview:**

This subject stars with the introduction of principles ofmicrowave and transmission lines with their applications. This subject explains about the microwave transmission lines like waveguides (rectangular, circular), micro-strips etc. and the various microwave components like T-junctions, circulator, isolator etc. Finally about the M-type tubes,microwave solid state devices and microwave measurements.

Course Objectives:

1. To introduce the microwave transmission lines and analyze electromagnetic wave propagation through rectangular waveguides..
2. To describe the various microwave components like T-junctions, circulator, isolator.
3. To describe the M-type tubes and Microwave solid state devices.
4. Gives the knowledge about the microwave equipments and measurements.

Course Outcomes:

**After going through this course the student will be able to**

- Develop the knowledge on transmission lines for microwaves, strip lines, its types and characteristics of waveguides
- Analysis & design passive microwave components such as directional couplers, power dividers / combiner and etc, with given characteristics
- Understand and analyze operating principles of basic microwave tubes such as klystrons and helix TWTs
- Understand the operating principles of basic passive and active microwave devices.
- Evaluate the key skill of Designing the microwave bench using waveguides

## SYLLABUS

**UNIT–I MICROWAVE AND TRANSMISSION LINES:** Introduction, microwave spectrum and bands, applications of microwaves. rectangular waveguides –solution of wave equations in rectangular coordinates, TE/TM mode analysis, expressions for fields, characteristic equation and cut-off frequencies, filter characteristics, dominant and degenerate modes, sketches of TE and TM mode fields in the cross-section, mode characteristics -phase and group velocities, wavelengths and impedance relations related problems rectangular guide- power transmission and power losses Impossibility of TEM mode, micro strip lines– introduction, ZO relations, effective dielectric constant, losses, Q factor ,cavity resonators– introduction, rectangular cavities, dominant modes and resonant frequencies, Q factor and coupling coefficients, related Problems.

**UNIT–II**
**WAVEGUIDE COMPONENTS AND APPLICATIONS:** Coupling mechanisms – probe, loop, aperture types, waveguide discontinuities – waveguide windows, tuning screws and posts, matched loads, waveguide attenuators – resistive card, rotary vane types; waveguide phase shifters – dielectric, rotary vane types, waveguide

multiport junctions – E plane and H plane tees, magic tee, hybrid ring, directional couplers – 2 hole, bethe hole types, related problems ferrites– composition and characteristics, faraday rotation, ferrite components – gyrator, isolator, circulator, scattering matrix–significance, formulation and properties, S matrix calculations for – 2 port junction, e plane and h plane tees, magic tee, directional coupler, circulator and isolator, related problems.

**UNIT–III**

**MICROWAVE TUBES:** Limitations and losses of conventional tubes at microwave frequencies, microwave tubes – O type and M type classifications, O-type tubes: 2 cavity klystrons – structure, re- entrant cavities, velocity modulation process and applegate diagram, bunching process and small signal theory – expressions for o/p power and efficiency. reflex klystrons – structure, applegate diagram and principle of working, mathematical theory of bunching, power output, efficiency, oscillating modes and o/p characteristics, effect of repeller voltage on power o/p, related problems, HELIX TWTS: Significance, types and characteristics of slow wave structures, structure of TWT and amplification process (qualitative treatment), suppression of oscillations, gain considerations.

**UNIT–IV**

**YPE TUBES**: Introduction, cross-field effects, magnetrons – different types, 8-cavity cylindrical travelling wave magnetron – Hull Cut-off and Hartree Conditions, modes of resonance and PI-mode operation, separation of Pi-mode, o/p characteristics.

**MICROWAVE SOLID STATE DEVICES:** Introduction, Classification, Applications. TEDs - Introduction, Gunn Diode - Principle, RWH Theory, Characteristics, Basic Modes of Operation, Gunn Oscillation Modes. LSA mode Avalanche Transit Time Devices.

**UNIT–V**

**MICROWAVE MEASUREMENTS:** Description of Microwave Bench – Different Blocks and their Features, Precautions; Microwave Power Measurement - Bolometers, Measurement of Attenuation, Frequency standing wave measurements –measurement of low and High VSWR, Cavity Q. Impedance Measurements.

**TEXT BOOKS:**


1. Samuel Y. Liao (1994), *Microwave Devices and Circuits*, 3rd edition, Prentice Hall of India, New Delhi.
2. Herbert J. Reich, J. G. Skalnik, P. F. Ordung, H. L. Krauss (2004), *Microwave Principles,* CBS Publishers, New Delhi, India.
3. M. Kulkarni (1998), *Micro Wave and Radar Engineering,* Umesh Publications, New Delhi.




**REFERENCE BOOKS:**


1. R. E. Collin (2002), *Foundations for Microwave Engineering,* 2nd edition, IEEE Press, John Wiley India.
2. M. L. Sisodia, G. S. Raghuvanshi (1995), *Microwave Circuits and Passive Devices,* Wiley Eastern Ltd., New Age International Publishers Ltd.
3. Peter A. Rizzi (1999), *Microwave Engineering Passive Circuits*, Prentice Hall of India, New Delhi.