**Techno India NJR Institute of Technology**



**Course File**

**Session 2023-24**

**Microwave Theory & Techniques(5EC4-05)**

Mr. Hitesh Sen

(Associate Professor)

**Department of ECE**

****

**Course Overview:**

Student will learn fundamentals of Microwave theory and techniques from this 40-hour course. In this course, student will study the fundamental concepts and application of different microwave devices and systems. Also, they will learnto design different microwave devices like amplifier, oscillator, mixer etc. used in various communication applications.

**Course Outcomes:**

|  |  |  |
| --- | --- | --- |
| **CO.NO.** | **Cognitive Level** | **Course Outcome**  |
| 1 | Knowledge | Explain the working of rectangular waveguides in different modes. |
| 2 | Comprehension | Evaluate impedance , admittance ,current gain and voltage gain using different types of parameters.   |
| 3 | Application | Illustrate the working of microwave passive components. |
| 4 | Analysis | Calculate microwave measurements such as VSWR ,power measurements etc. |
| 5 | Synthesis | Develop the MW devices and its application, and transmission of microwave over the satellite channel.  |

**Prerequisites:**

1. Fundamentals of microwave signal.
2. Must have completed the course on Electromagnetic theory.
3. Student should be able to solve the problems of physics of semiconductor devices.

**Course Outcome Mapping with Program Outcome:**

|  |  |
| --- | --- |
| **Course Outcome**  | **Program Outcomes (PO’s)** |
| **CO. NO.** | **Domain Specific**  | **Domain Independent**  |
|  | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 2 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **CO2** | 2 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **CO3** | 2 | 1 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **CO4** | 2 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **CO5** | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1: Slight (Low) , 2: Moderate (Medium), 3: Substantial (High)  |

**Course Coverage Module Wise:**

|  |  |  |
| --- | --- | --- |
| **Lecture No.** | **Unit** | **Topic** |
|  | **1** | **IMPEDANCE TRANSFORMATION AND MATCHING:** |
|  | 1 | Lumped elements for MICs and MMICs |
|  | 1 | printed inductors, capacitors and resonant elements |
|  | 1 | The Smith chart- combined impedance-admittance chart |
|  | 1 | Impedance matching with lumped elements (L networks) |
|  | 1 | Smith chart solutions |
|  | 1 | Single stub tuning in microstrip circuits using shunt stub |
|  | 1 | Single section quarter-wave transformer,  |
|  | 1 | Numerical |
|  | **2** | **MICROWAVE DIODES AND DIODE CIRCUITS:** Detector Diodes |
|  | 2 | Silicon crystal diode and Schottky diode |
|  | 2 | V-I characteristic of detector diode |
|  | 2 | basic operation of detection and mixing, single diode mixer circuit |
|  | 2 | PIN diode - Equivalent circuit and characteristics of PIN diode |
|  | 2 | single-pole PIN diode switches, single bit phase shifters |
|  | 2 | Varactor diode- Device characteristics and circuit applications |
|  | 2 | Gunn diode- Gunn effect, Gunn diode principle of operation and characteristics |
|  | 2 |  Typical oscillator circuit using Gunn diode.  |
|  | 2 | IMPATT diode- Characteristics, |
|  | 2 | IMPATT negative resistance, power output and efficiency, Numerical |
|  | **3** | **MICROWAVE TRANSISTORS AND CIRCUITS:** |
|  | 3 | Bipolar Junction Transistors (BJTs) – Geometry of silicon bipolar transistor |
|  | 3 | BJT DC biasing, microwave equivalent circuit and characteristics. |
|  | 3 | Microwave Field Effect Transistors (FETs) - Physical structure and principle of operation of JFET |
|  | 3 | MOSFET and MESFET characteristics |
|  | 3 | comparison of FET devices and circuit applications |
|  | 3 | Single stage FET amplifier – Block schematic of a single stage FET amplifier circuit, Stability considerations |
|  | 3 | analysis and derivation of expression for transducer gain with unilateral transistor, design criteria for maximum gain |
|  | **4** | **KLYSTRONS:** Limitations of conventional vacuum tubes |
|  | 4 | Reflex klystron – Basic schematic, mechanism of operation, modes of oscillation and modulation |
|  | 4 | Velocity modulation and electron bunching (analytical treatment) |
|  | 4 | Magnetrons- Types of magnetron, Basic structure of magnetron |
|  | 4 | Magnetron analysis, resonant modes in magnetron, operation, mechanism of oscillations |
|  | 4 | practical consideration of cavity magnetron, Introduction to coaxial |
|  | 4 | frequency angle and voltage tunable magnetrons, Numerical |
|  | **5** | **TWO CAVITY KLYSTRON AMPLIFIER**- Basic schematic and mechanism of operation.  |
|  | 5 | Travelling Wave Tube Amplifier- Basic schematic of helix type TWT tube |
|  | 5 | Introduction to CW power pulsed dual mode TWT |
|  | 5 | TWT amplifier operational characteristics |
|  | 5 | Applications of TWT, Crossed- field amplifier, Numerical |

**TEXT/REFERENCE BOOKS**

# Microwave Engineering,[David M. Pozar](https://www.amazon.com/David-M-Pozar/e/B001I9RQLI/ref%3Ddp_byline_cont_book_1),Wiley.

1. Microwave Devices and circuits, Samuel Y. Liao, Prentice Hall
2. Microwave and Radar Engineering, M. Kulkarni, Umesh Publication

**Teaching and Learning resources:**

* **MOOC (NPTEL): -**https://nptel.ac.in/courses/108/101/108101112/

**Assessment Methodology:**

1. Practical exam using lab instruments.
2. Two Midterm exams where student have to showcase subjective learning.
3. Final Exam (subjective paper) at the end of the semester.









