SCHEME OF EXAMINATION AND SYLLABUS

FOR

M.TECH. IN MICROWAVE ELECTRONICS

EXAMINATION FOR M. TECH. IN MICROWAVE ELECTRONICS

1. There shall be an M.Tech. course in Microwave Electronics in the Department of Electronic Science under the Faculty of Interdisciplinary and Applied Science.

2. The duration of the course will be four semesters which is two academic years.

3. A candidate seeking admission to this course must have passed M.Sc. Electronics or M.Sc. Physics with specialization in Electronics of this University or an equivalent examination of other Universities with at least 60% marks or an equivalent grade.

OR

A candidate seeking admission must have passed B.E. Electrical/Electronics/Electronics and Communication/Instrumentation Engineering from University of Delhi or an equivalent examination of other Universities with at least 60% marks or an equivalent grade.

Further a candidate must pass written Entrance Examination which will be based on the **following topics**:

Engineering Mathematics, Networks Analysis, Basics of Computer Programming and Numerical Techniques, Semiconductor Devices, Analog and Digital Communication, Electromagnetics, Transmission Lines and Basics of Microwaves.

All admissions to the course must be completed before July 31 of the year based on the merit list of the Entrance Examination **in the first instance.**

If a student does not attend at least 90% of the classes for two weeks after taking admission, his admission will be automatically cancelled and seat will be offered to the next candidate in the waiting list except incase of a medical reason.

4. No person shall be qualified for admission to the M.Tech. Course unless he/she is at least 21 years of age before the First Day of October in the year in which he/she seeks admission. However, the Vice Chancellor may, on the basis of individual merit, relax the age limit up to a maximum period of six months.

5. Examinations:

There shall be following four Semester Examinations in the course:

Semester I Examination: On completion of the course of study for the period prescribed therein in November/December of first year of the course.

A student will be promoted to the second semester provided he/she has not failed in more than two theory papers and has obtained not less than 50% marks in the aggregate of theory and practicals taken together.

The student will have to essentially repeat (ER) and pass in those papers in which he/she has failed. However, the student has to appear in the carried over papers only along with the regular students of the respective semesters in the course of reading which is prescribed for the fresh students, i.e., odd semester papers in odd semesters (I/III) and even semester papers in even semesters (II/IV).

Semester II Examination: On completion of the course of study for the period prescribed therein in April/May of the first year of the course.

A student will be promoted to the third Semester provided he/she has not failed in more than a total of two theory papers, inclusive of Semester I and Semester II, and has obtained not less than 50% marks in the aggregate of theory and practicals taken together in the Semester II examination. The student cannot carry over more than two papers for essential repeat at any stage.

Semester III Examination: On completion of the course of study for the period prescribed therein in November/December of the second year of the course.

A student will be promoted to the fourth Semester provided he/she has not failed in more than a total of two theory papers, inclusive of Semester I, Semester II and Semester III, and has obtained not less than 50% marks in the aggregate of theory and practicals taken together in the Semester III examination. The student cannot carry over more than two papers for essential repeat at any stage.

Semester IV Examination: At the end of the fourth semester in the last week of July. The minimum marks required to pass the fourth Semester shall be 50% in project.

IMPORTANT

A. A student can appear in any theory paper only twice, i.e., once in the original attempt and once in a repeat attempt.

B. The minimum marks required to pass each theory paper shall be 40% in the University Semester Examination (30/75) and 40% in the total of the University Semester Examination and the Internal Assessment taken together.

Attendance: In the case of the I, II and III semester examination, no candidate shall be deemed to have pursued a regular course of study unless one has attended at least three fourths (75%) of the total lectures delivered/classes held in the theory papers and practical papers taken separately. In case of the Semester IV examination, no candidate shall be allowed to appear at the same unless the supervisor guiding the candidate for the Dissertation work has reported that he/she is satisfied about the project work provided that such reports both from the supervisor and organization shall be to the satisfaction of the Head, Department of Electronic Science.

NOTE

Out of 100 marks in each theory paper, 20 marks will be reserved for sessionals (internal assessment) and 5 marks will be reserved for attendance as per University guidelines.

Each theory paper shall be of three hours duration.

Each practical paper shall be of six hours duration in one day and shall carry 100 marks out of which 40 marks shall be reserved for laboratory record and 5 marks for attendance in the practical classes.

Students will be required to work on the major project from January-July in Semester IV. The project can be carried out either completely in the Department or in collaboration with some Industry or an R & D Organization. In the later case, collaboration is to be established by the individual project supervisor.

On completion of the project work, in the month of July, the candidate will submit a dissertation and appear in a viva-voce examination.

6. Classification of Successful Candidates :

At the end of final examination, the successful candidates shall be classified on the basis marks obtained in the I, II. III and IV semester examinations taken together as follows:

First Division with distinction: 75% or more marks in the aggregate.
First Division: 60% or more marks but less than 75% marks in the aggregate.
Second Division: All others.

If a student fails in any paper, he/she will not be eligible for a merit position.

7. Miscellaneous:

a) The calendar for the academic year will be framed and declared at the beginning of the session.
b) Scholarship will be discontinued if the student fails to score at least 60% marks in any examination.
c) The span period for the M.Tech Degree will be four years.
d) A candidate who fails in the I, II or III Semester Examination will be required to repeat that part of the course as a regular student only.
e) There will be no provision of an ex-student
f) In the case of a student who repeats one or more theory papers, the internal assessment marks will be carried forward.
g) A candidate, who fails in the Semester IV Examination, will be required to repeat the Project. However, he/she may be allowed to complete it in next six months. Such a candidate will be examined in January of that year.
h) There will be no scope of improvement or revaluation.
i) The medium of instruction and examination shall be English.
j) Subject to the statues and ordinance of the University, M.Tech. Course student shall remain under the control and discipline of the Head, Department of Electronic Science.

I. Scheme of Examination:

The following shall be the scheme of examination for the course:

Semester I

1.1 Electromagnetic Theory and Transmission Lines	100
1.2 Microwave and MM-Wave Planar Transmission Lines	100
1.3 Microwave Measurement Techniques and Industrial Microwaves	100
1.4 Microwave Devices	100
1.5 Microwave Measurements Laboratory	100
TOTAL	**500**

Semester II

2.1 Microwave Passive Components	100
2.2 Antenna Theory and Techniques	100
2.3 Communication Theory and Wave Propagation	100
2.4 Computational Electromagnetics	100
2.5 Computational Laboratory	100
TOTAL	**500**

Semester III

3.1 Microwave Active Circuits	100
3.2 Communication Systems	100
3.3 Microwave Integrated Circuits (CAD, Fabrication and Measurements)	200
TOTAL	**400**

Semester IV

4.1 Major Project (six months duration)	**400**
TOTAL (FOUR SEMESTERS)	**1800**

II. Detailed Syllabus

1.1 Electromagnetic Theory and Transmission Lines

Maxwell's equations, generalized current concept, energy and power, complete power, singularities of the field; Introduction to waves: Plane waves in dielectric and conducting media, reflection and refraction of waves; Basic theory of transmission lines; Computation of RLCG parameters of two wire and classical lines; Smith chart and its applications; Scalar, vector and Hertz potentials and their relations to fields, and gauges; Theorems and concepts: The source concept, duality, uniqueness, image theory, the equivalence principle, fields in half space, reciprocity, construction of solutions; Concept of modes, rectangular wave guide, rectangular cavity, partially filled wave guides, dielectric slab guide, surface guided waves, non-resonant dielectric(NRD) guide; Modal expansion of fields and its applications.

1.2 Microwave and MM-Wave Planar Transmission Lines

Review of development and application of the modern transmission line structures as interconnect and as a medium for realization of components for the MIC and MMIC; Quasi-static and frequency dependent closed form models of microstrip line for effective relative permittivity, characteristic impedance, and dielectric and conductor losses; Effect of conductor thickness, top shield and side-walls on the propagation characteristics of a microstrip line; Closed form models for the coplanar waveguide line for effective relative permittivity, characteristic impedance, and dielectric and conductor losses; Introduction to slot line; Characteristics of coupled microstrip and coupled coplanar waveguide; Circuit models of discontinuities in microstrip lines and the coplanar waveguides: Open ended, short, gap, step, bent, T- junction. Microstrip line resonator; Microstrip patch resonators- rectangular, circular and ring; Quasi-static space domain and spectral domain analysis of microstrip line, coupled microstrip line and coplanar waveguide.

1.3 Microwave Measurement Techniques and Industrial Microwaves

Microwave Waveguide Components: Attenuators, phase shifters, matched loads, detectors and mounts, slotted-sections, E-plane tee, H-plane tee, hybrid tees, directional douplers, tuners, circulators and isolators; Signal generators: Fixed frequency, sweep frequency and synthesized frequency oscillators; Noise sources and noise meters used in microwave measurements; Frequency meters and VSWR meters; Measurements of frequency, attenuation, VSWR and impedance; Cavity measurements: Q-factor, bandwidth; Dielectric and magnetic properties of materials: Cavity and Waveguide methods; Measurements of power: Calorimetric and Microwave bridges; Principles of time domain and frequency domain reflectometry, spectrum analyser and network analyser; Measurement of Scattering parameters of passive and active devices.

Microwave in process control instrumentation; Microwave waste disposal; Microwave in agriculture and medicine, hyperthermia etc.; Microwave heating; Microwave absorbers; EMC and EMI.

1.4 Microwave Devices

Microwave Transistor; Microwave Tunnel Diode; Varacter Diode; Schottky Diode; MESFET: Principle of operation, equivalent circuit, cut off frequency, power frequency limitations; MOS Structures; MOSFET: mechanism, modes of operation, transconductance, max operating frequency and microwave applications; HEMT: Structure, operation, characteristics, transconductance and cut off frequency, microwave applications; Charge Coupled Devices (CCD); Transferred Electron Devices: Gunn Diode, LSA Diode, modes of operation, Microwave Generation and Amplification; Avalanche Effect Devices: Read diode, carrier current and external current; IMPATT diodes.

Klystron: Velocity modulation process, bunching process, output power and beam loading; Reflex Klystron: power output and efficiency; Traveling Wave Tubes; Magnetron.

1.5 Microwave Measurements Laboratory

2.1 Microwave Passive Components and Circuits

The transmission line section as a basic component; Application of Thevenin's theorem to a transmission line; Transfer function of a transmission line section; T and PI representation of a transmission line section; Analysis of two ports and multiports network by using Z, Y and transmission matrix; S-parameter analysis of the microwave circuits; Conversion of Z, Y, transmission parameters and S-parameters; Matching networks: Reactive matching network using the lumped elements; Quarter wavelength transformer, multi section transformer matching section; Lumped planar components like capacitor, inductor and balun; Power divider, Branch line coupler, hybrid ring coupler, directional coupler; Analysis of these components using the S-parameters; Richard transformation and Kurda identities; Inverters, Design of microwave planar filters; Planar Non reciprocal devices: Circulator, delay lines and phase shifters; MEMS technology based microwave components like switches, filters, phase shifters and delay lines.

2.2 Antenna Theory and Techniques

Theory of electromagnetic radiation; Coordinate system and transformation of field quantities in different coordinate system; Basic concept and definition: Directive gain, side lobe, back lobe, polarization, co-polarization and cross polarization level, beam width, input impedance, bandwidth, efficiency; Various kind of antenna with applications; Formulation of radiation integrals and its application to analysis of wire, loop and helix type antenna; Theory of aperture antenna, including the Fourier transform method and application to slot, waveguide and horn antenna; Design consideration of parabolic reflector antenna; Microstrip antenna: Rectangular and circular patch; Feed to microstrip antenna: probe feed, microstrip line feed, aperture feed, electromagnetically fed microstrip patch; Circularly polarized microstrip antenna; Theory of linear array: Two element and multi element array, isotropic and non-isotropic array, Binomial and Chebyshev distribution; Planar array, phased array and adaptive antenna; Feed network of microstrip antenna array; Antenna for mobile communication: handset antenna and base station antenna.

2.3 Communication Theory and Wave Propagation

Probability and random variables; Baye's theorem; Probability density and probability distribution functions, statistical expectation, moments and characteristic functions, various distributions, multiple random variables, transformation of PDFs; Random Processes: Basic concept, description of random process, correlation functions, Stationary and non-stationary process, ergodic process, power and energy;
Multiple random process; Random processes in frequency domain; Fourier transform of random processes, power spectrum of stochastic processes; Gaussian and White processes; Markov process; Various modulation systems and multiple access systems like FDMA, TDMA and CDMA.
Wave Propagation: Free space propagation model, ground reflection; Earth and its effect on propagation, terrain formation considerations and its effects on free transmission, Diffraction and scattering from obstacles; Atmospheric attenuation; Practical link budget; Troposphere propagation; Tropo system fading characteristics; Troposcatter loss calculations; Fading in LOS troposcatter; Statistical behavior of fading; Diversity techniques.

2.4 Computational Electromagnetics

Review of analytical methods; Green's function; Finite difference methods: Various finite difference schemes, finite differencing of PDEs, accuracy and stability of FD solutions; applications to guided structures such as transmission lines, waveguides; Finite Difference Time Domain Method (FDTD): Yee's FD algorithm, accuracy and stability, lattice truncation conditions, initial fields, programming aspects, absorbing boundary conditions for FDTD; Method of Moments: Introduction, Integral equations, Green's functions, applications to quasi-static problems, radiation problems, mutual impedance between linear elememts, mutual coupling in arrays, rectangular arrays, grating lobe considerations; Applications of FDTD and Method of Moments to wave guide, fin line, planar lines and planar antennas.

2.5 Computational Laboratory

3.1 Microwave Active Circuits

Introduction to RF and Microwave active circuits and its application to MMIC; Description of a complete system; Signal flow diagram; Equivalent circuit and models of microwave diode and transistor. S-parameter description of active devices; Classification of RF amplifiers for low noise, medium power and high power application; Biasing, stability and Noise consideration; Matching considerations for maximum power and minimum reflection; Design of microwave amplifier circuits: Narrow band amplifies; broad band amplifiers, broadband matching; Classification and Design of microwave oscillators: characteristics and performance evaluation; Phase locked loop circuit; Basic mixer concept: Frequency domain characteristics, Single ended mixer design, Single and double balanced mixer. Design consideration and evaluation of a complete receiver and transmitter system.

3.2 Communication Systems

Introduction to Wireless Communication Systems; Global system for mobile(GSM): Cellular concept, System design, Transmission system; Receiving system; Frequency reuse; Channel interference and system capacity; Outdoor and indoor propagation models, small scale and multipath fading; practical link budget; Digital modulation with reference to wireless communication; Spread spectrum modulation; Modulation performances in fading and multipath channel; Multiple access techniques as applied to wireless communication; Pocket Radio system; Wireless networking: 1G, 2G, 3G wireless networks, traffic routing; wireless data service.

Introduction to Satellite Systems; Orbiting satellites, satellite frequency bands, communication satellite systems, satellite modulation and multiple access formats; Satellite systems in India; Satellite receiving systems, G/T ratio; Satellite uplink and downlink analyses in C, Ku and Ka bands; Spot beam, multiple beam, frequency reuse; Satellite transponder; Satellite front end.

Introduction to Optical Communication Systems; Optical fibers, sources and detectors; Analog and Digital systems; Modulation and multiplexing; Power budget analysis; Synchronous optical networks (SONET/SDH); Fiber distributed data interface (FDDI).

3.3 Microwave Integrated Circuits

CAD of Microwave Integrated Circuits, fabrication and measurements

4.1 Major Project (six months duration)