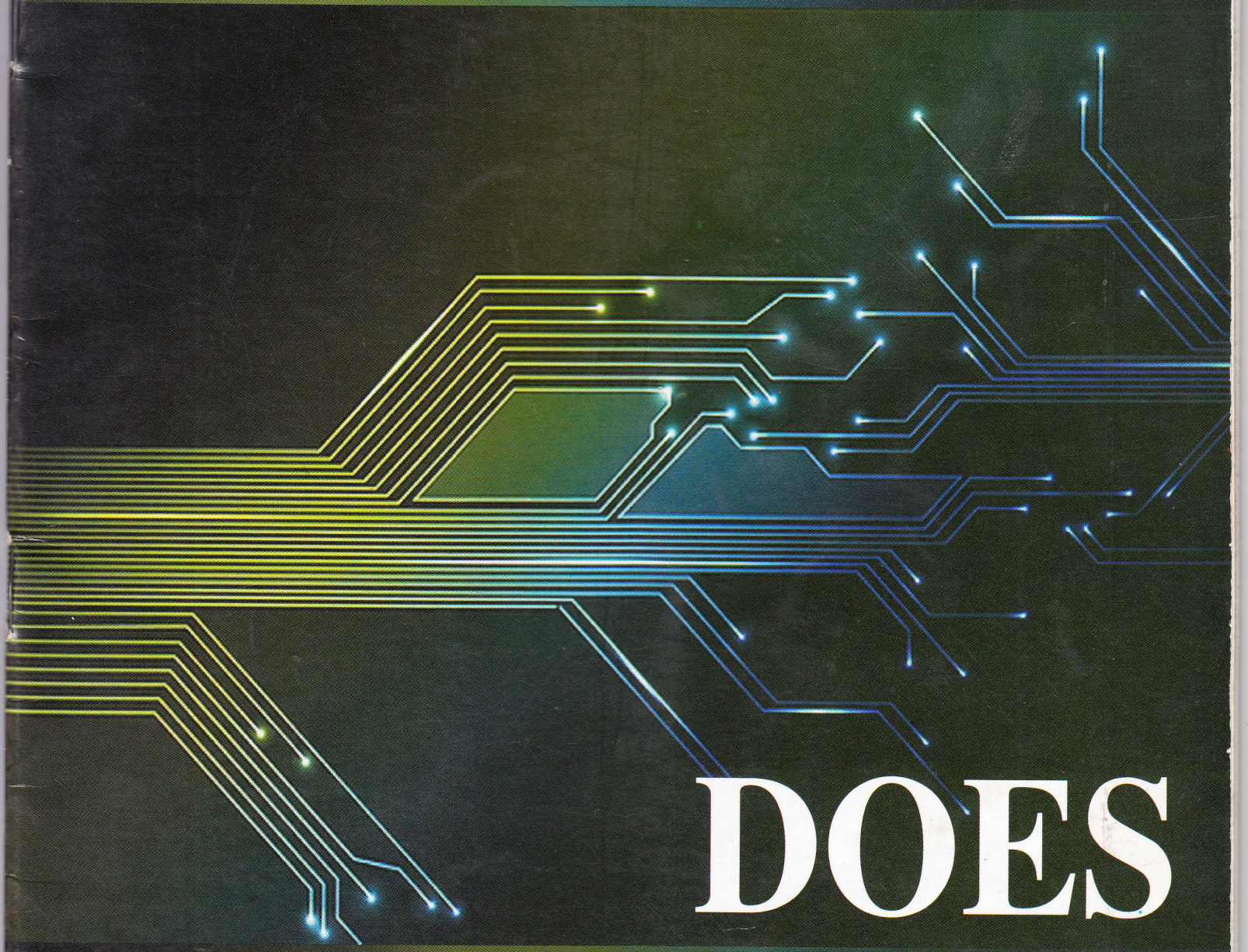
Department of Electronic Science



DOES

University of Delhi South Campus
Benito Juarez Road, New Delhi-110 021

UDSC

University of Delhi South Campus

The University of Delhi, established in 1922, is a premier University of the country, known for high standards in teaching and research. The University initiated in the early seventies a new concept of a multi-campus system. The South-Campus is the- first new Campus, spread over an area of 69 acres amidst the natural green surroundings on the Aravali hill range. The Campus has developed beautifully with full facilities for students. There is a well equipped library and an Internet Access Network. Hostel accommodation is available on the campus for both, girls and boys.

The South Campus has come to have its own identity by exclusively offering post-graduate courses of applied and professional nature in several subjects and endeavoured to achieve excellence both in teaching and research. The Department of Electronic Science, under the Faculty of Interdisciplinary and Applied Sciences, offers such courses at the M.Sc. level in Electronics as well as the M.Tech. level in Microwave Electronics, and has good research facilities in several areas. The other Departments under the Faculty include Biochemistry, Biophysics, Genetics, Microbiology and Plant Molecular Biology. To keep in pace with the vast changes brought about by the revolution in information technology an Institute of Informatics and Communication has also been established under this Faculty.

The South Campus endeavors have been to develop an ideal environment where the students can grow and become socially conscious, disciplined, responsible and inspiring leaders of the future.

Department of Electronic Science

The Department of Electronic Science was established in 1985 and is widely recognised as one of the most prestigious Electronic Science Departments in the country.

The Department is conducting courses leading to M.Tech in Microwave Electronics and M.Sc. in Electronics. The aim of these programmes is to provide the necessary theoretical background and practical experience in order to meet the requirements of the R&D Organizations and Industries. All students joining the M.Sc. course are required to undergo summer training in the Industry or R&D Organisations. In addition, the M.Tech and M.Sc. students work for 6 months on projects in collaboration with Industry and R&D Organisations. The curriculum of these courses is updated regularly to keep it in consonance with the changing industrial environment. The interface with the Industry is further enhanced by an annual seminar under the Visitor's Programme in which professionals from industry, R&D organizations and academics are invited. Our alumini, now spread over a large number of government and private organisations, facilitate these interactions.

A full range of resources and facilities are available to the students. The department has a well equipped computer laboratory with various circuit simulation and microwave design software for students. In addition, there are well equipped laboratories for experimental work in the following areas: Microwave Measurements, Communication Electronics, Circuit Design, Electrical Machines and Control Systems, Electronic Materials and Semiconductor Devices, Microprocessors and Digital Signal Processing and Optical Electronics.
Attempt is made to assess the students' performance through continuous series of tests and presentations in addition to semester end examinations to ensure highest standards.

The Department is actively helping the students in their placement through Campus interviews. Students graduating from the Department have

Infrastructure Facilities

The laboratory training in the department provides students with an exposure to the state of art technologies. This gives them practical skills to meet the growing challenges of industry, R & D and academics.

The laboratory course provides a system level understanding of the 8086 microprocessor involved in the design of microprocessor based electronic equipment. It involves in depth studies of software architecture, instruction set and assembly level programming with PC.

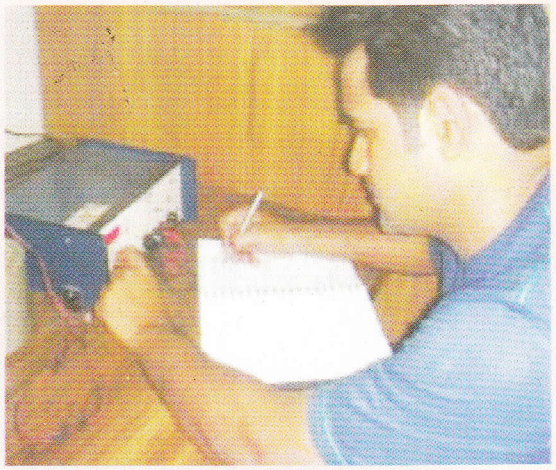
Computer Facility

The computer facility of the department is equipped with the latest computers and software packages. A formal course in computational techniques provides all students an understanding of numerical techniques and efficient programming practice in high level programming languages. Students are encouraged to use both FORTRAN 77 and C/C++. Use of mathematical tools like Mathcad and Matlab for solving class assignments is also encouraged. Circuit simulation tools like PSpice and Electronic Workbench as well as powerful simulation and design tools for microwave circuits are also available. Internet connectivity is available in the computer lab and other laboratories of the Department.

Semiconductor Materials and Devices

The semiconductor devices and materials laboratory provides experimental setups to study and measure various properties of semiconductor materials. These include Hall measurements, Four -probe method, Vander Pauw Method etc. In addition, characteristics of semiconductor devices like UJT, FET, MOSFET, SCR etc. are also studied.

Integrated Circuit Technology has revolutionized electronics . The laboratory provides an exposure to instruments needed in the initial steps for integrated circuits. This includes creation and measurement of vacuum, deposition of thin films on substrates and pattern transfer techniques like photolithography. A C-V plotter is also available to study the characteristics of devices. More recently sophisticated facilities like x-ray diffraction, UV-VIS-NIR spectrophotometer and Kiethley source-meter have been added with support from the DST (FIST) grant.

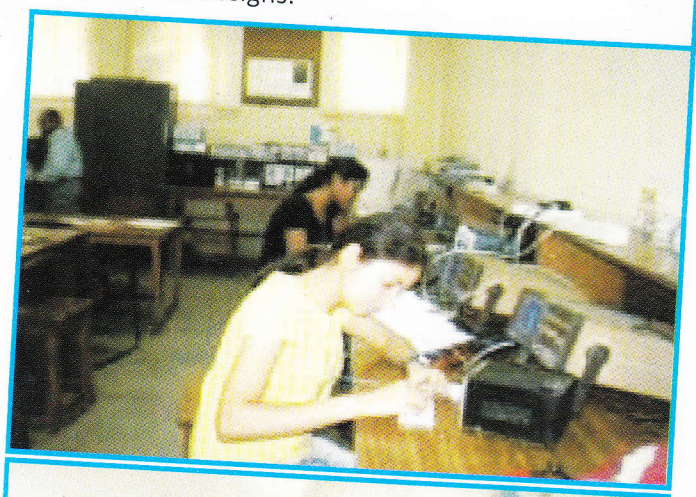


Microprocessors and Digital Signal Processing

The laboratory course provides a system level understanding of the 8086 microprocessor involved in the design of microprocessor based electronic equipment. It involves in depth studies of software architecture, instruction set and assembly level programming with PC interfacing.

The students also undertake the programming of the microcontroller 8051 and the interfacing of peripherals.

Digital Signal Processing technology and applications have seen a rapid growth over the last decade. An exposure to this technology is provided through TMSC2054 DSP chips in stand alone mode and with a PC interface. It includes programming for arithmetic operations, waveform generation and the more complex filter designs.



Circuit Design and Simulation

The circuit design laboratory focuses on design of both analog and digital circuits. For a better understanding the design exercises are carried out using discrete active and passive components as well as ICs. Circuit design and simulation software packages like Multisim, PSpice VHDL, active HDL and Electronic Workbench are also used for design and simulation before hardware implementation. Kits for FPGA implementation of digital design are also there. This gives the students a first exposure to design tools used in the semiconductor industry. Advanced simulators like 2D ATLAS, 3D ATLAS, MADICHI and ISE TCAD are also available for use in project work by students.

Communication and Control

Communication laboratory provides a package of experiments that give practical understanding and implementation of Analog and Digital Communication Circuits. It includes basic experiments such as AM, FM, PAM, PWM, PCM, DM, and their application in transreceiver systems.

The experiments on system control include SCR controlled DC motor, DC and AC servo motors, error signal generation, angular variation & analysis, PID control of DC motor with computer interface, Programmable Logic Controller (PLC) and DC Motor Position Control.

Optical Electronics

The laboratory begins with simple experiments designed to understand wave phenomena like diffraction, polarization, Fourier Optics with a laser source on an optical bench. Online pattern measurements by a CCD array connected to a PC have also been introduced. This is followed by characterization of optical sources and detectors, optical fibers and demonstration of optical communication. Fiber splicing machine is also there in the Lab. In addition assignments based on the software package "Understanding Fiber Optics on a PC" provide a comprehensive understanding of the optical fibre. A powerful tool for design of integrated optical devices based on the beam propagation method, BPMCAD from OPTIWAVE is also available for design projects. Units for understanding lasing action in Nd-Yag laser and study of non-linear effects have also been introduced.

Microwave Measurements and Electromagnetics

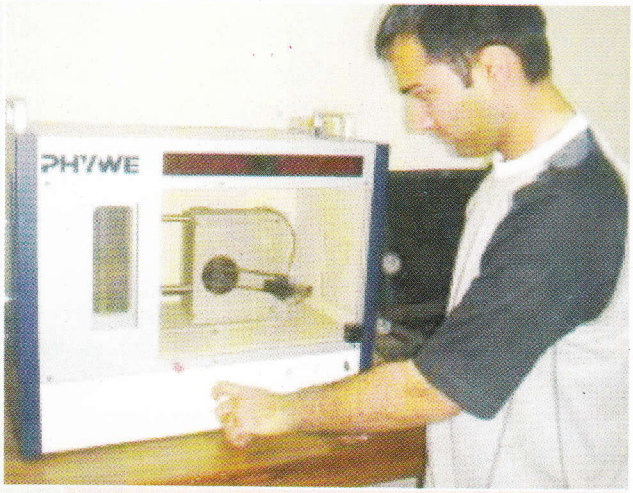
The Microwave laboratory, with benches for experimental work at the X-band, provides the basic training on microwave measurements. These measurements introduce the basic concepts of waveguides and transmission lines, characterization of Gunn and Klystron sources, cavity resonators, directional couplers etc. Measurements on an antenna turn-table provide basic understanding of the antenna radiation pattern and its parameters. Sophisticated equipment such as Network Analyzer with RF source is also available for measurements on Microwave Integrated Circuits. Advanced Microstrip Trainer Kit is also available in the Lab to impart knowledge about microwave circuits using microstrip technology. Department as milling machine for the PCB fabrication facility and on chip Probe Station.

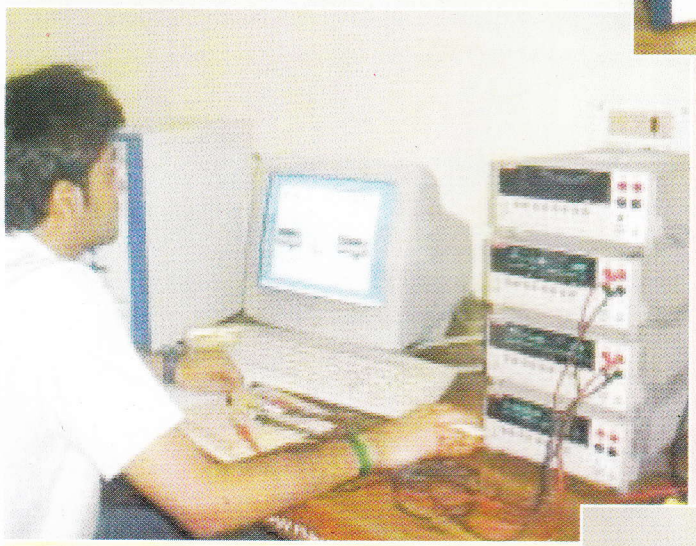
Microwave Integrated Circuits

The design and simulation of microwave -integrated circuits forms an important component of the M.Tech. Course. The department has over the time procured some of the best electromagnetic simulators: Ensamble from ANSOFT, IE3D and Empire. Hewlett-- Packard in recognizing the department as a major center of microwave education presented a work-station and one of the best software tools - EESOF's advanced design software and Momentum. As part of the curriculum students design and simulate various planar microwave circuits like filters, couplers etc., get them fabricated and finally test them with measurements on the Network Analyzer.

DST –FIST Programme

The department has received major grants from DST under FIST (Funds for Improvement of S&T Infrastructure) programme [448] [PSI-075]. In this programme, three instruments namely X-ray diffractometer, UV VIS NIR spectrophotometer and source meter has been procured and commissioned by the department.





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

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; Quasistatic 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 Microwave Active Circuits

3.1 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 amplifiers; 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).

1. Scheme of Examination

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

Semester I		
1.1	High-level Computer Language and Operating System	50
1.2	Engineering Mathematics	50
1.3	Network Analysis and Synthesis	50
1.4	Advanced Analog and Digital Circuit Design	50
1.5	Practical I : High level Computer Languages and Operating Systems	25
1.6	Practical II : Electronic Circuits	25
1.7	Practical III : Microprocessors	25
1.8	Practical IV : Computational Techniques	25
	Semester I total	**300**
Semester II		
2.1	Electromagnetics, Antenna and Propagation	50
2.2	Seminconductor Devices and Materials	50
2.3	Microprocessors	50
2.4	Signal Systems and Control	50
2.5	Practical I : Electromagnetics	25
2.6	Practical II : Materials and Semiconductor Devices	25
2.7	Practical III : Circuit Design and Simulation	25
2.8	Practical IV : Electrical Machines and Control Systems	25
	Semester II total	**300**
	Summer Training (8 weeks)	**50**
Semester III		
3.1	Optical Electronics	50
3.2	Integrated Circuit Technology	50
3.3	Digital Signal Processing	50
3.4	Communication Systems	50
3.5	Practical I : Optical Electronics	25
3.6	Practical II : Science and Technology of Semiconductor Devices	25
3.7	Practical III : Digital Signal Processing	25
3.8	Practical IV : Communication Systems	25
	Semester III total	**300**
Semester IV		
4.1	Quantum Electronics	50
4.2	VLSI Circuit Design and Device Modeling	50
4.3	Modern Communication Systems	50
4.4	Microwave Electronics	50
4.5	Seminar	25
4.6	Lectures from Industry	25
4.7	Project	200
	Semester IV total	**450**
	Grand Total	**1400**

Detailed Syllabus

1.1 High-level Computer Languages and Operating Systems

Operating Systems: familiarity with various operating systems like DOS, OSII, GUI like Windows, UNIX & LINUX. Details of one operating system such as UNIX: introduction, multitasking, multiuser capabilities, UNIX basis, files and directories, understanding the UNIX shell, text processing in the UNIX environment, editors like VI, EMAC, SED. Programming languages (one high level language such as C++) : introduction to C++ and object oriented programming, development environment, compiling and linking the source code, brief look at crout, comments,' variable and constants, expressions and statements, functions, classes, pointers, references, overloading, arrays, inheritance, special classes and functions, streams and files, the preprocessor, object-oriented analysis and design, templates, exceptions & error handling, standard libraries and bit manipulation.

1.2 Engineering Mathematics

Sturm-Liouville's problem: applications and examples. Calculus of variations with examples. Partial differential equations: Laplace, wave and diffusion equations in various coordinate systems. Integral equations and methods of solutions. Green's function technique and its application. Approximate techniques of engineering mathematics: perturbation method, variational methods, method of weighted residues, WKB method. Contour integration, conformal mapping. Transforms: Laplace, Fourier & FFT.

1.3 Network Analysis and Synthesis

Time domain analysis of networks (differential equation approach). Thevenin and Norton's theorems, reciprocity theorem, Tellagan's and Millman's Theorems. System function approach to network analysis, graph theory, mesh and node analysis, poles and Zeros. Laplace Transform, Hurwitz Polynomials, positive real functions. Synthesis of reactive ports by Foster's and Cauer's Methods. Synthesis of R-L, R-C, and R-L-C-networks.

1.4 Advanced Analog and Digital Circuit Design

Practical Analog and Digital Circuit Design of amplifiers (single and multistage, audio and RF range) and power amplifiers. Design process as a troubleshooting tool. Oscillators, Mixers and PLL. Review of Logic families tabular and computer aides minimisation procedures. Programmable Logic Array. Clock mode sequential machines, incompletely specified sequential machines and fundamental mode sequential machines.

1.5 Practical I : Hiqh level Computer Languages and Operating Systems-

1.6 Practical II : Electronic Circuits

1.7 Practical III : Microprocessors

1.8 Practical IV : Computational Techniques

2.1 Electromagnetics, Antenna and Propagation

Transmission lines: transmission line equation in time and frequency domain, losses and dispersion, reflection from an unknown load; quarter wavelength, single stub and double stub matching; Smith Chart and its applications. Maxwell's equations, constitutive relations, wave equation, plane wave functions, rectangular waveguide, circular waveguide, dielectric slab waveguide surface guided waves. Antenna parameters, radiation from simple dipole and aperture, concept of antenna arrays, end fire and broadside arrays, horn antenna, microstrip antenna, parabolic disc antenna., Ground wave, space wave and ionospheric propagation. Communication link budget for ground transmission.

2.2 Semiconductor Devices and Materials

Crystalline, polycrystalline and amorphous semiconductors: energy bands, carrier transport, excess carriers. injection and recombination of the excess carriers, the mechanisms involved. Basic equations for semiconductor device operations: continuity equation, current flow equation, carrier transport equation and their solutions. Binary, ternary and quaternary compounds and their applications. Characterisation of semiconducting materials. p-n Junction diodes: abrupt and linear, electrical breakdown, tunnel diode, Schottky barrier diode, majority carrier diodes. Microwave diodes: Varactor diode, p-i-n diode, transferred electron devices. Optoelectronic devices: solar cell, photodetector, LED, semiconductor laser. JFET, MESFET, MOS capacitor, MIS diode, MOSFET. Basic idea of charge coupled Devices. Quantum well structures and low dimension physics.

2.3 Microprocessors

Microprocessor based design, design constraints, microprocessor selection, hardware implementation, software implementation, hardware debugging, software debugging. Introduction to 8086, 8088, 80186, 80188, 6800, 68000 and other latest chips of Intel/Motorala microprocessors. 8086 Internal architecture, introduction to programmable parallel ports and hand-shake, input-output, interfacing the microprocessor to keyboards, alphanumeric displays and high power devices. The 8086 Maximum code, DMA data transfer interfacing and refreshing dynamic RAM, processors with integrated peripherals, the 80186, the 8087 math coprocessor. Multiple bus microcomputer system.

2.4 Signal Systems and Control

Introduction with examples of. various kinds of continuous and discrete time signals and their mathematical representation. Signal energy and power. Even and odd signals. Periodic, exponential and sinusoidal signals. Unit impulse and unit step functions for both discrete and continuous time signals. Examples and mathematical representation of continuous and discrete time systems. Difference equation. Basic vector matrix form of state equation. Basic system properties. Discrete time Linear Time Invariant (LTI) systems with cQnvolution sum. Continuous time LTI system with convolution integral. Fourier series and transform application to analysis of signals and systems.

Introduction to control with examples of feedback control systems from several fields. Block diagram, transfer function and signal flow graph. Mathematical modelling of physical systems. Time domain and frequency domain analysis of control systems. Stability criteria, rootlocus techniques.

2.5 Practical I : Electromagnetics

2.6 Practical II : Electronic Materials and Semiconductor Devices

2.7 Practical III : Circuit Design and Simulation

2.8 Practical IV : Electrical Machines and Control Systems

3.1 Optical Electronics

Review of basic optics: wave propagation, polarisation, diffraction, Gaussian beams. Electrooptic effect, electro-optic modulators and their design considerations. Acousto-optic effect, Raman Nath and Bragg diffraction, acousto-optic modulators and deflectors. Principles of optical communication systems, optical sources and detectors. Optical fibers: modes of an optical fiber, multimode fibers, single mode fibers and their propagation characteristics. Dispersion management in optical fibers and link design considerations. Integrated optics: planar and channel waveguides, directional couplers, optical switch, electro-optic and acousto-optic waveguide devices. Display devices, holography and optical information processing.

3.2 Integrated Circuit Technology

Material purification. Epitaxial growth: LPE, VPE, MBE. Clean room specifications and requirements. Vacuum technology, sputtering, oxidation, growth mechanism and kinetics (thin and ultrathin oxides), oxidation techniques, redistribution of dopants at the interface and oxidation induced defects.

Diffusion: Fick's law, diffusion mechanism, measurement techniques, diffusion in SiO_2. Ion Implantation : systems and dose control, ion range, ion stopping, knock on ranges, metalization choices. Etching: dry etching, pattern transfer, plasma etching, sputter etching, control of etch rate and selectivity, control of edge profile. Process simulation and process integration. Lithography: optical, electron beam, ion beam, X-ray lithography, lift off, dip pen. Pattern generation. Fabrication of few devices like MMIC, laser diode etc.

3.3 Digital Signal Processing

Discrete time signal analysis and linear systems. Sampling of continuous time signals. Z-transform, properties of region of convergence of Z-transform, inverse Z-transform, unilateral Z-transform. Structures of discrete time systems, block diagram and signal flow graph representation of linear constant coefficient difference equation. Basic structures for ILR and FIR filters, lattice structures, effect of coefficient quantisation, effects of round-off noise in digital filters. Filter design techniques, Discrete Fourier Transform and Fast Fourier Transforms. Concept of multirate digital signal processing.

3.4 Communication Systems

Frequency allocation and standards. Analog Transmission: AM, FM and PM (modulation, demodulation techniques and noise Analysis), AM and FM transmitters and receivers. Digital transmission: sampling and digital multiplexing techniques, PAM, PWM, PPM, PCM, DM, line codes, Information theory, ASK, FSK, PSK and QAM.

3.5 Practical I : Optical Electronics

3.6 Practical II : Science and Technology of Semiconductor Devices

3.7 Practical III : Digital Signal Processing

3.8 Practical IV : Communication Systems

4.1 Quantum Electronics

Interaction of radiation with matter: light amplification and laser operation. Optical resonators. Properties of laser radiation, mode selection, Q-switching and mode locking. Various types of lasers and applications:

gas lasers, solid-ion lasers etc. Semiconductors lasers. Optical amplifiers: doped fiber amplifiers, design considerations, amplified spontaneous emission (ASE) and noise figure. Nonlinear optics: second and third order nonlinerity, second harmonic generation; sum and difference frequency generation, parametric amplification, stimulated Raman and Brillouin scattering, self phase modulation, temporal and spatial solitons.

4.2 VLSI Circuit Design and Device Modeling

Passive elements design, design of silicon integrated circuits. Basic MOS inverter design, transfer characteristics, logic threshold, NAND & NOR logic, transit time and inverter time delay, depletion and enhancement modes, CMOS inverter, inverting and non-inverting type super buffers. Optimization of NMOS and CMOS inverters, noise margins MOS design rules. MOS layers, Stick diagrams, NMOS design layout diagrams, CMOS design, design rules and layout. Lamda bases design rules. Scaling of MOS Circuits. Functional Limitations to scaHng, scaling of wires and interconnections. MOS memories and programmable logic arrays, non-volatile semiconductor memeories with MOS technology. General considerations associated with VLSI design. Design of a four-bit shifter, design of an ALU sybsystem. Physical model for Si VLSf, MOSFET modeling, short channel structures, scaled down MOS performance. Packaging of VLSI devices, packaging types. Packaging design consideration, VLSI assembly technology and fabrication technologies. Mechanism of yield loss in VLSI, modeling of yield loss mechanism, reliability requirements for VLSI. Failure mechanism in VLSI. Fault finding in VLSI chips.

4.3 Modern Communication Systems

Data transfer and computer networking: packet switching, ISDN, ATM, LAN, WAN, Internet and WAP. Digital Radio Communication Systems; Transmission media, sampling, multiplexing, digital modulation and multiple access techniques.

Satellite Communication Systems: principles of satellite communication, modulation, multiplexing and; multiple access techniques; satellite services like DBS, VSAT etc. Mobile communication: specifications, design approach and details. Optical Communication Systems: network topologies, Fiber Distributed Data Interface (FDDI) network, Synchronous Optical Network (SONET/SDH), Asynchronous Transfer Mode (ATM), Wavelength Division Multiplexing (WDM) and its network implementation.

4.4 Microwave Electronics

Introduction to microwaves and their publications; Klystron amplifiers: operation and analysis, power and efficiency, multi cavity klystron. Reflex klystrons: operation and analysis, electronic admittance, electronic tuning, power output and deficiency. Magnetrons: operation and analysis. Travelling Wave Tubes: operation, gain bandwidth, coupling and focusing methods, applications. Avalanche Diode, Gunn effect and Gunn diode oscillators. Solid state microwave amplifiers, oscillators and mixers. Microwave components: attenuator, phase shifter, slotted lines, frequency meter, directional couplers, E-plane Tee, Magic Tee and Ferrite devices basic measurements of frequency, SWR, impedance and power at microwave frequencies. Principles of microwave LOS communication. Introduction to RADAR.

4.5 Seminar

4.6 Lectures from Industry

4.7 Project

INFORMATION BULLETIN

M.Tech. MICROWAVE ELECTRONICS
and
M.Sc. ELECTRONICS

2001-2002

DEPARTMENT OF ELECTRONIC SCIENCE
UNIVERSITY OF DELHI SOUTH CAMPUS
BENITO JUAREZ ROAD
NEW DELHI 110021

DEPARTMENT OF ELECTRONIC SCIENCE
University of Delhi South Campus

ADMISSION TO M.Tech. and M.Sc. COURSES

IMPORTANT INFORMATION

M.Tech Microwave Electronics

Last Date for obtaining and submitting Application Forms	5.07.2001
Date of Entrance Test	7.07.2001
Time of Entrance Test	10 a.m.
Seats for admission by Entrance Test	16
Sponsored Seats for Defence	04
Result of Entrance Test	7.07.2001
Commencement of Classes	16.07.2001

M.Sc. Electronics

Last Date for obtaining and submitting Application Forms	10.07.2001
Date of Entrance Test	12.07.2001
Time of Entrance Test	10 a.m.
Seats for admission by Entrance Test	10
Seats for direct admission	10
Result of Entrance Test	14.07.2001
Commencement of Classes	16.07.2001

Venue of Entrance Tests
S.P. Jain Centre
University of Delhi South Campus

Professor P.K. Bhatnagar
Head, Department of Electronic Science:
Tel.: 6112440, 6111995 ext. 204

THE M.Sc. COURSE CURRICULUM AT A GLANCE

	SEMESTER I	
1.1	High-level Computer Languages and Operating Systems	50
1.2	Engineering Mathematics	50
1.3	Network Analysis and Synthesis	50
1.4	Advanced Analog and Digital Circuit Design	50
1.5	Practical I: Workshop Practice	25
1.6	Practical II: Electronic Circuits	25
1.7	Practical III: Microprocessors	25
1.8	Practical IV: Computational Techniques	25
	Semester I total	**300**
	SEMESTER II	
2.1	Electromagnetics, Antenna and Propagation	50
2.2	Semiconductor Devices and Materials	50
2.3	Microprocessors	50
2.4	Signal Systems and Control	50
2.5	Practical I: Electromagnetics	25
2.6	Practical II: Materials and Semiconductor Devices	25
2.7	Practical III: Circuit Design and Simulation	25
2.8	Practical IV: Electrical Machines and Control Systems	25
	Semester II total	**300**
	Summer Training (8 weeks)	**50**
	SEMESTER III	
3.1	Optical Electronics	50
3.2	Integrated Circuit Technology	50
3.3	Digital Signal Processing	50
3.4	Communication Systems	50
3.5	Practical I: Optical Electronics	25
3.6	Practical II: Science and Technology of Semiconductor Devices	25
3.7	Practical III: Digital Signal Processing	25
3.8	Practical IV: Communication Systems	25
	Semester III total	**300**
	SEMESTER IV	
4.1	Quantum Electronics	50
4.2	VLSI Circuit Design and Device Modeling	50
4.3	Modern Communication Systems	50
4.4	Microwave Electronics	50
4.5	Seminar	25
4.6	Lectures from Industry	25
4.7	Project	200
	Semester IV total	**450**
	Grand Total	**1400**

Court Meeting : 27.8.2004

AMENDMENTS TO ORDINANCES
AND
APPENDICES TO ORDINANCES

(Amendments incorporated up to 10.2.2004)

IMPORTANT AMENDMENTS

UNIVERSITY OF DELHI

14. Amendments to Appendix II to Ordinance V (2) & VII of the Ordinances of the University regarding change in nomenclature of B.Sc. (Hons.) Physiotherapy Course (effective from the academic session 2004-2005) (Page 168 of the University Calendar, Volume II, 1989) (E.C. 10.2.2004).

Change the existing nomenclature of the following courses :-

Existing Provision	*Amended Provision*
1. 'B.sc. (Hons.) Physiotherapy Course'	'Bachelor of Physiotherapy (BPT 4-1/2 years).'
2. 'One year bridge course B.Sc. (Hons.) Physiotherapy	'Bachelor of Physiotherapy (Bridge Course) (BPT-one year).'

15. Amendments to Appendix II to Ordinance V (2) & VII of the Ordinances of the University relating to change in the duration of the M.Tech. in Microwave Electronics Course (effective from the academic session 2003-2004) (Page 596 of the University Calendar, Volume II, 1989) (E.C.10.2.2004).

Existing provision

"The duration of the course will be three semesters which is one and a half academic years."

Amended provision

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

Court Meeting : 14.1.2005

AMENDMENTS TO ORDINANCES
AND
APPENDICES TO ORDINANCES

Vol. I (Amendments incorporated up to 25.10.2004)

UNIVERSITY OF DELHI

16. **Amendments to Appendix II to Ordinance V(2) & VII of the Ordinances of the University regarding revision of Ordinance of M.Tech. Microwave Electronics (effective from the academic session 2004-2005) (Page 596 of University Calendar, Volume II, 1989) (E.C. 4.6.2004).**

Replace the following with the existing Ordinance :

M.Tech. 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 a written **All India 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.

Candidates appearing for the final year of the qualifying examinations in the year of admission can also apply provided they are in a position to obtain their qualifying degree before October 15 of that year.

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 as per rules.

5. The total number of seats is Twenty (20) of which Sixteen (16) will be filled through the Entrance Test. Four (4) seats will be reserved for candidates sponsored from Government organizations like Defence, ISRO, DRDO, CSIR etc.

6. The fee includes Rs. 2000/- laboratory development fee (non-refundable) each year in addition to the usual University fees.

   For sponsored candidates the Laboratory development fee will be a total of Rs. 20,000/= to be paid at the time of admission.

7. **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, 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.

8. Classification of Successful Candidates

At the end of final examination, the successful candidates shall be classified on the basis of 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.

9. 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 statutes and ordinances of the University, M.Tech. Course student shall remain under the control and discipline of the Head, Department of Electronic Science.

10. 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

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.