

**GURUGRAM UNIVERSITY**  
**SCHEME OF STUDIES AND EXAMINATION**  
**M.TECH 1st YEAR (ELECTRONICS & COMMUNICATION ENGINEERING)**  
**SEMESTER - 1**

Sl. No	Course Code	Subject	Credit Pattern				Examination Schedule (Marks)				Duration of Exam (Hours)	No of Hours /week	
			L	T	P	Total Credits	Marks of Class work	Theory	Practical	Total			
1	16ECE21C1	Advance Microprocessor & Microcontroller	4	0	-	4	50	100	-	150	3	4	
2	16ECE21C2	Satellite and Space Communication	4	0	-	4	50	100	-	150	3	4	
3	16ECE21C3	Information and Communication Theory	4	0	-	4	50	100	-	150	3	4	
4	16ECE21C4	Advanced Digital Signal Processing	4	0	-	4	50	100	-	150	3	4	
5	16ECE21C5	Data Communication Networks	4	0	-	4	50	100	-	150	3	4	
6	16ECE21C6	Seminar	-	-	-	2	50	-	-	50		2	
7	16ECE21CL1	Satellite Lab	-	-	2	2	50	-	50	100	3	4	
8	16ECE21CL2	Advance Microprocessor & Microcontroller Lab	-	-	2	2	50	-	50	100	3	4	
		<b>TOTAL</b>					<b>26</b>						

NOTE:

**Examiner will set nine question in total. Question One will be compulsory and will comprise short answer type questions from all sections and remaining eight questions to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.**

**GURUGRAM UNIVERSITY**  
**SCHEME OF STUDIES AND EXAMINATION**  
**M.TECH 1st YEAR (ELECTRONICS & COMMUNICATION ENGINEERING)**  
**SEMESTER 2**

Sl No	Course No.	Subject	Credit Pattern			Examination Schedule (Marks)				Duration of Exam (Hours)
			T	P	Total Credits	Marks of Class works	Theory	Practical	Total	
1	16ECE22C1	Wireless Mobile Communication	4	0	4	50	100	-	150	3
2	16ECE22C2	Optical Communication	4	0	4	50	100	-	150	3
3	16ECE22C3	Seminar	-	-	2	50	-	-	50	
4	16ECE22CL1	VLSI Lab	-	-	2	50	-	50	100	3
5	16ECE22CL2	Optical Communication Lab	-	-	2	50	-	50	100	3
6	16ECE22D1 or 16ECE22D2 or 16ECE22D3 or 16ECE22D4	Elective-1	4	0	4	50	100	-	150	3
7		Open Elective			3					
8		Foundation Elective			2					
<b>TOTAL</b>						<b>23</b>				

**NOTE:** Examiner will set nine questions in total. Question One will be compulsory and will comprise short answer type questions from all sections and remaining eight questions to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

**Elective 1 : Choose any one from the following four papers:**

16ECE22D1 - Electronic System Design

16ECE22D2 - Image Processing

16ECE22D3 – ADVANCED MATHEMATICS FOR ENGINEERS

16ECE22D4 - VLSI Design

**Open Elective:** A candidate has to select this paper from the pool of Open Electives provided by the University.

**Foundation Elective:** A candidate has to select this paper from the pool of Foundation Electives provided by the University.

**16ECE21C1                      ADVANCED MICROPROCESSOR & MICROCONTROLLERS**

L	T	P	Marks	Credits
4	-	-	Exams : 100	4
			Sessionals : 50	
			Total : 150	4
			Duration of Exam : 3 hrs.	

**COURSE OUTCOMES:** After the completion of the course the student will be able to:

CO1 Understand the operation and architecture of Intel microprocessor 8085, 8086, Motorola 68XXX family microprocessor, Microcontroller 8051 including Instruction Set Architecture, assembly language programming, timing and speed of operation.

CO2 Learn the operation of circuits for user interaction through switches, keyboard and display devices.

CO3 Understand the operation and architecture of Intel 8085, 8086, Motorola 68XXX family microprocessor including Instruction Set Architecture, assembly language programming, timing and speed of operation.

CO4 Understand the motivation and need for peripheral operations circuits for digital data exchange, timer, serial communication, merits of direct memory access, interrupt controller and other circuits.

**SECTION - A**

**Design of basic microprocessor architectural Concepts :** Microprocessor architecture, word lengths, addressable memory, Microprocessor's speed architectural characteristics, registers, instruction, memory addressing architecture, ALU, GPR's Control logic & internal data bus.

**Microprocessor Instructions & Communication:** Instruction Set, Mnemonics, Basic Instruction Types, Addressing modes, Microprocessor I/O connecting I/O to Microprocessor, Polling and Interrupts, Interrupt and DM. Controllers.

**SECTION B**

**Microcontroller:** Introduction 8051 architecture and programming model. Internal RAM and registers, I/O parts, Interrupt system & Instruction sets.

**SECTION C**

**Advanced microprocessors:** Intel X86 family of advanced Microprocessor, programming model for 86 family. X85 addressing modes, instruction set, hardware. Motorola 68XXX family of microprocessor, 68XXX addressing modes, instruction set, hardware.

**SECTION D**

**Microprocessor I/O:** Data Communication, parallel I/O serial communication, Serial interface and UART modems, I/O devices, D/A, A/D interface, special I/O devices.

**Developing Microprocessor Based Products:** Introduction to the Design Process, Preparing the specifications, Developing a design, Implementing and Testing and design, Regulatory Compliance Testing, design tool for Microprocessor Development.

**Text Books:**

C.M.Gilmore, "MicroprocessorsPrincipalsandApplication", MGH

Rajkamal, "Embedded System, Architecture & Programming", TMH

**ReferenceBooks:**

BerryB. Berry, " InterSeries ofmicroprocessors", PHI

D. V. Hall, "Microprocessor & Interfacing", TMH

Peatman, "MicroprocessorBasedSystemDesign", Pearson

**NOTE: For setting up the question paper, Question No. 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9**

questions.

## 16ECE21C2 SATELLITE AND SPACE COMMUNICATION

L	T	P	Marks	Credits
4	-	-	Exams : 100	4
			Sessionals : 50	
			Total : 150	4
			Duration of Exam : 3 hrs.	

### Section-A

**COURSE OUTCOMES:** After the completion of the course the student will be able to:

CO1 understand the working of satellite in space.

CO2 understand orbital parameters of satellite in space.

CO3 take up R&D in Satellite and space communication.

**Introduction :** Brief History of evolution & growth of communication satellite, Synchronous satellite, Satellite frequency allocation & Band spectrum, Advantages of satellite communication, Active & Passive satellite. Applications of satellite communication.

### Section-B

**Orbits of satellite:** Kepler's Laws, Low, medium and Geo synchronous main characteristics, Angle period, Returning period, Angle of Evaluation, Propagation Delay, Orbital Spacing.

**Satellite Links:** Design of down links, up link design, Delay transponders, Earth Stations, Antennas and Earth coverage, Altitude and eclipses

### Section-C

**Earth space propagation effects:** Free space loss, Atmospheric absorption, Rainfall Attenuation, Ionospheric scintillation, Telemetry, Tracking and command of satellites.

**Detection:** QPSK offset QPSK and MSK. Coherent and non coherent detection. Error rate performance.

### Section-D

**Synchronization:** Principle and techniques, Multiple Access Techniques, FDMA, TDMA system: concept and configuration, system timing frames format, VSAT, Random access, space communication, TELSAT and INSAT system. GPS systems

### Text Books

1. Satellite Communications : Dennis Roddy, TMH
2. Satellite Communication : D.C. Aggarwal ; Khanna Publishers.

### Reference Books

- 1 J. Martin: Communication Satellite System, PH Englewood.
- 2 Satellite Communication: T. Pratt and C.W. Boston, John Willey and sons
- 3 Satellite Communication : Monojit Mitra, PHI
- 4 Fundamentals of satellite Communication: K.N.Raja Rao, PHI

**NOTE:** For setting up the question paper, Question No. 1 will be set up from all the

**four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.**

**16ECE21C3**

**INFORMATION & COMMUNICATION THEORY**

L	T	P	Marks	Credits
4	-	-	Exams : 100	4
			Sessionals : 50	
			Total : 150	4
			Duration of Exam : 3 hrs.	

**COURSE OUTCOMES (CO):**

By the end of this course the student will

- CO1 be aware about the trends in communication technology and how it impacts channel performance.
- CO2 Be able to learn about Source encoding & channel encoding.
- CO3 understand various channel coding techniques & their performances.
- CO4 be able to design communication model with less probability of error.

**SECTION A**

**Information Theory:** Concept of Information and Entropy, Shannon's theorems, Channel Capacity Self information, Discrete and Continuous entropy, Mutual and joint information, Redundancy.

**SECTION B**

**Coding Theory:** Source encoding & channel encoding, Error detection & Correction, Various codes for channel coding, Rate Distortion functions.

**SECTION C**

**Codes used in Information Theory:** Linear block codes, systematic linear codes & optimum coding for Binary symmetric channel, The Generator & parity check matrices, Syndrome decoding & Symmetric channels, Hamming codes, Weight enumerator, Perfect codes, BCH codes, Idempotent & Mattson Solomon polynomials, Reed Solomon codes, Justen codes, MDS codes & generalized BCH codes, Convolution codes & Viterbi decoding algorithm.

**SECTION D**

**Performance of codes:** Performance of linear block codes & convolution codes, code incurable error probability Upper & lower bounds.

**Textbooks:**

1. Blahut R.E. , Theory and practice of error control codes, AWL1983.
2. Wilson, Digital Modulation and coding, Pearson

**Reference Books:**

1. B.P. Lathi, Communication System, Oxford
2. Ranjan Bose, Information Theory, Coding & Cryptography, TMH
3. J. Dass. , S.K. Malik & P.K. Chatterjee, Principles of digital communication

**NOTE: For setting up the question paper, Question No. 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.**



**16ECE21C4**

**ADVANCED DIGITAL SIGNAL PROCESSING**

L	T	P	Marks	Credits
4	-	-	Exams : 100	4
			Sessionals : 50	
			Total : 150	4
			Duration of Exam : 3 hrs.	

**COURSE OUTCOMES:** After the completion of the course the student will be able to:

- CO1 Possess basic background in digital signal processing area necessary for supporting subjects such as: communication principles, computer networks, speech processing, audio processing, image and video processing
- CO2 Possess necessary background for advance studies in DSP, especially for taking the subject Advanced Digital Signal Processing, or other multimedia signal processing subjects.
- CO3 Analyze the basic of properties of signals and systems like time invariance, stability, causality, linearity etc. Compute the linear and Circular convolutions of discrete time sequences.
- CO4 Understand the basic theories behind DTFT/DFT/Z/FFT for practical applications.
- CO5 have a comprehensive understanding of analysis and design of linear-phase FIR digital filters used in decimation & interpolation, and their computationally efficient implementation techniques.

**SECTION A**

**Introduction of DSP:** Introduction to Signal Processing, Discrete Linear Systems, superposition Principle, Unit-Sample response, stability & causality Criterion.

**Fourier Transform & inverse Fourier transform:** Frequency domain design of digital filters, Fourier transform, use of Fourier transform in Signal processing. The inverse Fourier transform, Sampling continuous function to generate a sequence, Reconstruction of continuous -time signals from Discrete-time sequences.

**SECTION B**

**DFT & FFT & Z transform with Applications:** Discrete Fourier transform, properties of DFT, Circular Convolution, Fast Fourier Transform, Realizations of DFT. The Z-transform, the system function of a digital filter, Digital Filter implementation from the system function, the inverse Z- transform, properties & applications, Special computation of finite sequences, sequence of infinite length & continuous time signals, computation of Fourier series & time sequences from spectra.

**SECTION C**

**Digital Filter Structure & Implementation:** Linearity, time- invariance & causality, the discrete convolution, the transfer function, stability tests, steady state response, Amplitude & Phase characteristics, stabilization procedure, Ideal LP Filter, Physical realizability & specifications. FIR Filters, Truncation windowing & Delays, design example, IIR Filters: Review of design of analog filters & analog frequency transformation. Digital frequency transformation. Design of LP filters using impulse invariance method, Bilinear transformation, Phase equalizer, digital allpass filters.

**SECTION D**

**Implementation of Filters:** Realization block diagrams, Cascade & parallel realization, effect of infinite-word length, transfer function of degree 1&2, Sensitivity comparisons, effects of finite precision arithmetic on Digital filters.

**Text Books**

1. Alan V. Oppenheim & Ronald W. Schaffer, "Digital Signal Processing" PHI.
2. JG Proakis, "Digital Signal Processing", (PHI) 3rd Edition.

**Reference Books**

1. Rabiner & Gold, "Theory & application of digital Signal Processing", PHI 1992.

Roman kuc, "Introduction to Digital Signal Processing," McGrawhill Edition.

NOTE: For setting up the question paper, Question No. 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.

**16ECE21C5**

**DATA COMMUNICATION NETWORKS**

L T P  
4 - -

	Marks	Credits
Exam :	100	4
Sessionals :	50	
Total :	150	4

Duration of Exam : 3 hrs.

**Course outcomes:**

By the end of this course the students will be able

CO1. To understand the working nature of different communication networks, communication system and their components.

CO2. To understand the various transmission media used in data communication system.

CO3. To understand the various layers and their functions and to identify the different types of network topologies and their protocols.

**SECTION A**

**Introduction to Data Transmission:** Overview of Data Communication and networking, Analog And Digital Data Transmission, Transmission Impairments, Various Transmission Media, Data Encoding.

**Digital Data Communication Techniques :** Asynchronous And Synchronous Transmission, Error Detection and correction techniques, Physical interfaces

**SECTION B**

**Data Link Control:** Link Configurations, Protocol principles (Error control, Flow control), Bit Oriented and character oriented protocol, Data link layer services, Link Control.

**Multiplexing:** F.D.M. Synchronous TDM, Statistical TDM

**SECTION C**

**Communication Networking Techniques:** Communication Networks, Circuit Switching, Message Switching, Packet Switching, Local Networking Technology, The bus / tree topology, the ring topology, Medium Access control protocols (CSMA/CD, Token ring, FDDI, DQDB).

**SECTION D**

**Computer Communication Architecture:** OSI and TCP/IP Model, Protocol And Architecture, Networking Access protocols, Inter Networking, Transport layer Protocols, Session Service And Protocols, and Presentation/ Application protocols

**ISDN Networks:** Concepts & Architecture, Protocols

**Text Books :**

1. William Stallings, "Data and Computer Communication", PHI, 4<sup>th</sup> Ed.
2. Forouzan, "Data Communications and Networking", TMH

**Reference Books:**

1. AndrewTanenbaum,“ComputerNetworking”,PHI
2. Godbole,“Datacommunicationsandnetwork”,TMH

**NOTE: For setting up the question paper, Question No. 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.**

**16ECE21C6****SEMINAR**

L	T	P	Marks	Credits
-	-	2	Sessional : 50	
			Total : 50	2

At the end of this course the student shall be able to

CO1 prepare the topic and contents on a technical topic

CO2 speak on a technical topic effectively

CO3 enhance communication skills

Every student will be required to present a seminar talk on a topic approved by the Deptt. except on his/her dissertation. The committee constituted by the Head of the Deptt. will evaluate the presentation and will award one of the grades out of A+,A,B,C,D and E.

A Student who is awarded the 'F' grade will be required to repeat the seminar on the same topic.

**16ECE21CL1****SATELLITE LAB**

L	T	P	Marks	Credits
-	-	4	Exams : 50	
			Sessionals : 50	
			Total : 100	2
			Duration of Exam : 3 hrs.	

**COURSE OUTCOMES:** After the completion of the course the student will be able to:

- CO1 practically understand the working of satellite in space.
- CO2 practically understand orbital parameters of satellite in space.
- CO3 take up R&D in Satellite and space communication.

1. To Study the process of Transmitting Signal.
2. To Study the Baseband Signal in a Satellite Link.
3. To estimate C/N Ratio.
4. To estimate S/N Ratio.
5. To set up digital satellite Communication Link.
6. To Study Black & White and Color T.V.
7. To plot radiation pattern of parabolic reflector.
8. To Study Satellite Communication Receiver.
9. To set up a PC to PC Sat. Com. Link using RS –232 port.
10. To measure the propagation delay of signal in a Sat. Com. Link.
11. To transmit & receive the function generator waveform through a Sat. Com. Link.
12. To set up a active & passive satellite communication link & study their difference.

**NOTE:**

The scheme of awarding the grade to a student in the course will be supplied by the University to the examiner

**16ECE21CL2            ADVANCED MICROPROCESSOR & MICROCONTROLLER  
LAB**

L	T	P	Marks	Credits
-	-	4	Exams : 50	
			Sessionals : 50	
			Total : 100	2
			Duration of Exam : 3 hrs.	

**Course outcomes:**

On completion of this lab course the students will be able to:

CO1. Understand and apply the fundamentals of assembly level programming of microprocessors and microcontroller.

CO2. Work with standard microprocessor real time interfaces including, serial ports, digital-to-analog converters and analog-to-digital converters;

CO3. Analyze abstract problems and apply a combination of hardware and software to address the problem;

(A few experiments may be designed & included in this list depending upon the infrastructure available in the institute)

1. To study the architecture of 8086 Kit
2. Write an ALP to convert a hexadecimal No. to decimal No. in single step execution (DEBUG)
3. Write an ALP to enter a word from keyboard and to display
  1. Write an ALP for addition of two one digit Numbers.
  2. Write an ALP to display a string
  3. Write an ALP reverse a string
  4. Write an ALP to check whether the No. is Palindrome
5. To study the Microcontroller Kit
6. Write an ALP to generate 10 KHz frequency square wave
7. Write an ALP to generate 10 KHz & 100 KHz frequency using interrupt
8. Write an ALP to interface intelligent LCD display
9. Write an ALP to interface intelligent LED display
10. Write an ALP to Switch ON alarm when Microcontroller receive interrupt
11. Write an ALP to interface on a microcontroller with other using serial/parallel communication.

**NOTE:** The scheme of awarding the grades to a student in the course will be supplied by the University to the examiner.

<b>16ECE22C1</b>	<b>WIRELESS MOBILE COMMUNICATION</b>		
L	T	P	Marks
4	-	-	
			Exams : 100
			Sessionals : 50
			Total : 150
			Credits : 4
			Duration of Exam : 3 hrs.

## Course Outcomes

After completion of this course students will be able

- CO1 To understand the concept of cellular communication
- CO2 To understand the basics of wireless communication
- CO3 Knowledge of GSM mobile communication standard, its architecture, logical channels, advantages and limitations.
- CO4 Knowledge of IS-95 CDMA mobile communication standard, its architecture, logical channels, advantages and limitations.
- CO5 Knowledge of 3G mobile standards and their comparison with 2G technologies.

### SECTION A

**Introduction to mobile radio systems:** Paging systems, cordless telephone system, Cellular telephone systems- Cellular concept, frequency reuse, channel assignment strategies, Interference and system capacity, trunking and grade of service, cell splitting, sectoring, microcell zone concept, HO strategies.

### SECTION B

**Mobile radiopropagation:** mechanism, freespace path loss, log-distance path loss models, Okumara model, Hata model, PCS model, Wideband PCS microcell model, indoor propagation models, Jake's channel model, Multipath characteristics of radio waves, signal fading, Time dispersion, Dopplerspread, coherencetime LCR, fading statistics, diversity techniques

### SECTION C

**Introduction to spread spectrum communication, multiple access techniques used in mobile wireless communication:** FDMA/TDMA/CDMA, Cellular CDMA, packet radio protocols, CSMA, reservation protocols, capacity of cellular CDMA, soft HO

### SECTION D

**Wireless systems and standards:** GSM standards, signaling and call control, mobility management, location tracing, wireless data networking, packet error modeling on fading channels, Performance analysis of link and transport layer protocols over wireless channels, mobile data networking (mobile IP), wireless data services, IS-95, GPRS

#### Text Books:

1. T. S. Rappaport, "wireless Communications: Principles and practices", PHI 1996.
2. William C. Y. Lee, " Mobile Cellular Telecommunications, Analog and Digital Systems",



2nd ed, MGH-1995.

**Reference Books:**

1. Kaveh Pahlavan & Allen H. Levesque, "Wireless Information Networks", Wiley series in Telecommunications and signal processing.

Kamilo Feher: Wireless Digital Communications, Modulation and Spread Spectrum Applications PHI 2001.

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**16ECE22C2****OPTICAL COMMUNICATION**

L	T	P	Marks	Credits
4	-	-	Exams : 100	4
			Sessionals : 50	
			Total : 150	4
			Duration of Exam : 3 hrs.	

**Course Outcome:-**

At the end of this course

CO1 - The students have learned about all components of Optical Communication.

CO2 - Gained the fundamental knowledge about optical communication in designing of optical link.

CO3 - studied the optical transmitter and receiver and their desired characteristics

**SECTION A**

**Introduction:** Advantage of optical fiber communication, Elements of fiber communication link, Ray theory and electromagnetic mode theory for optical propagation, step index and graded index fibers, Numerical Aperture.

**Optical fibers, Losses & Dispersion:** Attenuation, Absorption, Linear and non-linear scattering losses, Dispersion, overall fiber dispersion, polarization, fiber bending losses, multimode step index and graded index fibers, single mode fiber, plastic clad and all-plastic fibers, optical fiber cables, dispersion shifted and dispersion flattened fibers, practical fiber profiles.

**SECTION B**

**Optical Sources:** Basic concepts: LED for Optical Communication, Burrus type double hetero-structure, Surface emitting LEDs, Shape geometry, Edge emitting LEDs, LED to fiber launch systems, semiconductor Lasers Theory, modulation and characteristics, Fabry-Perot lasers, quantum well lasers and distributed feedback lasers.

**Photo Detectors:** P.I.N Photo Diodes: Theory and their characteristics, Avalanche photo diode detectors, Theory and their bandwidth noise in APD.

**SECTION C**

**Optical fiber communication System:** Optical transmitter circuit : LED and laser drive circuits, optical receiver circuit; Structure, Pre amplifier, AGC, Equalization, Optical power budgeting line loading, analog systems : analog modulation, direct modulation, sub carrier modulation, distribution system, Optical TDM sub-carrier multiplexing, WDM.

**SECTION D**

**Coherent Systems :** Coherent receiver, Homodyne and heterodyne detection, noise in coherent receiver, polarization control, Homodyne receiver, Reusability and laser line-width, heterodyne receiver, synchronous, Asynchronous and self synchronous demodulation, phase diversity receivers.

**Textbooks:**

1. John Gowar, "Optical Communication Systems", PHI.
2. Gerd Keiser, "Optical Fiber Communication", TMH

**Reference Books:**

1. FranzJH&JainVK,“OpticalCommunication”,NarosaPublns

JohnM.Senior,“OpticalCommunication”,PHI

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16ECE22D4

## VLSI DESIGN

L	T	P	Marks	Credits
4	-	-	Exams : 100	4
			Sessionals : 50	
			Total : 150	4
			Duration of Exam : 3 hrs	

### SECTION A

#### COURSE OUTCOMES (CO):

- CO1 To be aware about the trends in semiconductor technology, and how it impacts scaling and performance.
- CO2 Able to learn Layout, Stick diagrams, Fabrication steps, Static and Switching characteristics of inverters.
- CO3 Synthesis of digital VLSI systems from register-transfer or higher level descriptions in hardware design languages.
- CO4 To understand MOS transistor as a switch and its capacitance.
- CO5 Student will be able to design digital systems using MOS circuits.

### SECTION A

**Review of MOS technology:** Basic MOS Transistors, Enhancement and Depletion mode transistors, N MOS and C MOS process, thermal aspects of processing, Production of masks.

### SECTION B

**Electrical properties of MOS circuit :** Parameters of MOS transistors, pass transistors, N MOS inverter, Pull-up to pull down ratio for an N MOS inverter, C MOS inverters, MOS transistor circuit model, Latch up on C MOS circuits.

### SECTION C

**Design processes :** MOS Layers, stick diagrams, Design rules, AWAOXC MOS process description, double metal single poly silicon, C MOS process.

**Basic circuit concepts:** Sheet resistance, area capacitance, delay unit, inverter delay, super buffers, propagation delays.

### SECTION D

**Subsystem Design & Layout :** Architectural issues in VLSI, switch logic, gate logic, Examples of Combinational logic, Clocked sequential circuits, other system consideration.

**Scaling of MOS circuits :** Scaling factor, limitations, scaling of wires and interconnection, PLA and Finite state Machines.

**Design Examples :** Design of an ALU subsystems, carry look ahead address, parallel.

#### Text Books:

1. Pucknell D. A. and Eshrachain K, "Basic VLSI Design System & Circuits". (PHI), 1988.

Geiger, Rr, Allen P. E. Strader N. R., "VLSI Design Techniques for Analog and Digital Circuit", MGH 1990`

#### Reference Books:

1. Wolf, "ModernVLSIDesign", Pearson  
SZE, "VLSITechnology", TMH

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**16ECE22C3****SEMINAR**

L	T	P	Marks	Credits
-	-	2	Sessional : 50	2
			Total : 50	2

At the end of this course the student shall be able to

CO1 prepare the topic and contents on a technical topic

CO2 speak on a technical topic effectively

CO3 enhance communication skills

Every student will be required to present a seminar talk on a topic approved by the Deptt. except on his/her dissertation. The committee constituted by the Head of the Deptt. will evaluate the presentation and will award one of the grades out of A+,A,B,C,D and E.

A Student who is awarded the 'F' grade will be required to repeat the seminar on the same topic.

**16ECE22CL1****VLSI LAB**

L	T	P	Marks	Credits
-	-	4	Exams : 50	
			Sessionals : 50	
			Total : 100	2
			Duration of Exam : 3 hrs.	

**Course Outcomes:**

By the end of the course the students will be able to:

CO1. Compare various MOS technologies.

CO2. Foster ability to simulate combinational logic circuits.

CO3. Perform design layouts for logic gates, combinational logic circuits and sequential circuits.

CO4. Be able to understand interworking of various gates and their combinations for testing.

1. Write a spice programme for CMOS inverter with following details.

pmos L = .8um W=12.0um, nmos = 8um W=2.4um, nmos (kp=60u Vto=0.6v)  
 pmos(kp=20u Vto=-0.8v)

2. Write a spice programme for CMOS NAND gate with following details:

Vdd=5v, pmos L=.8um W=20um, nmos L=8um W=um, nmos (kp=45u V to = 1.0v)  
 pmos (kp=25u Vto=-1.2v)

3. Write a spice programme for CMOS NOR gates with following details:

Vdd=5v, pmos L=8um W=20um, nmos L=8um W=8um, nmos (kp=45u Vto=1.0v)  
 Pmos (kp=25u Vto=-1.2v)

4. Design a D-latch with clk time period=6ns using NAND gates with following specification:

L=2U W=100U for n-p-mos, for n-mos Kn'=60U Vto=0.6V for p-mos kp=20U Vto=0.8V)

5. Design a half adder using NAND gates with following specifications :

for n-mos : L=2U W=100U, for p-mos L=2U W=650U, for n-mos Kn'=600 Vto=0.6V for  
 P-mos Kp=20U Vto=0.8v)

6. Design a full adder using half adder designed above.

7. Design the layout for PMOS in layout editor.

8. Design the Layout for NMOS in layout editor.

9. Design the layout for CMOS inverter with equal rise and fall time in layout editor.
10. Design the layout for 2-Input NAND gate.
11. Design the layout for 2-Input NOR gate.
12. Design the layout for clocked S-R flip-flop.



**16ECE22CL2****OPTICAL COMMUNICATION LAB**

L	T	P	Marks	Credits
-	-	4	Exams : 50	
			Sessionals : 50	
			Total : 100	2
			Duration of Exam : 3 hrs.	

**COURSE OUTCOMES (CO):**

CO1 - Will be able to design the optical network of various layer & needs.

CO2 - To use optical source and decoders for the link for voice data communication.

CO3 - To maintain and keep the link serviceable for reliable communication.

(A few experiments may be designed & included in this list depending upon the infrastructure available in the institute)

1. Study of optical devices.
2. Study of fiber optical detector.
3. Study of fiber optical transmitters
4. Determination of numerical aperture of optical fiber
5. Study of characteristics of LED.
6. Study of characteristics of LASER diode.
7. Setting up a fiber optical analog link.
8. Setting up a fiber optical digital link.
9. Study of modulation & demodulation of light source by direct amplitude modulation techniques.
10. Forming a PC to PC communication link using optical fiber & RS232.
11. Setting up a fiber optical voice link.
12. Study of modulation & demodulation of light source by PPM technique.
13. Study of modulation & demodulation of light source by PWM technique.
14. Study of Propagation loss & sending loss in optical fiber.

**16ECE22D1**

**ELECTRONIC SYSTEM DESIGN**

L	T	P	Marks	Credits
4	-	-	Exams : 100	4
			Sessionals : 50	
			Total : 150	4
			Duration of Exam : 3 hrs.	

**COURSE OUTCOMES:**

After the completion of the course the student will be able to:

- CO1 Understand the operation and architecture flip flop, registers and multiplexer,
- CO2 Design and operation of Clocked JK Flip Flop, Design Of Clock F/F, Output Decoders,
- CO3 Learn to provide Clock And Power Supply Requirements,
- CO4 Use of MSI Decoders, Multiplexers In System Controllers in the electronics circuit design.,
- CO5 Application , design and testing of ROM, PLA And PAL

**SECTION A**

**Review of Digital Electronics concept**

**MSI and LSI Circuits And Their Applications:** Arithmetic Circuits, Comparators, Multiplexers, Code Converters, XOR And AND-OR INVERTER Gates, Wired Logic, Bus Oriented Structures, Tri-State Bus System, Propagation Delay.

**SECTION B**

**Sequential Machines:** The Concept Of Memory, The Binary Cell, The Cell And The Bouncing Switch, Set/Reset, D, Clocked T, Clocked JK Flip Flop, Design Of Clock F/F, Conversion, Clocking Aspects, Clock Skew, State Diagram Synchronous Analysis Process, Design Steps For Traditional Synchronous Sequential Circuits, State Reduction, Design Steps For Next State Decoders, Design Of Out Put Decoders, Counters, Shift Registers and Memory.

**SECTION C**

**Multinput System Controller Design:** System Controllers, Design Phases And System Documentation, Defining The System, Timing And Frequency Considerations, Functional, Position And Detailed Flow Diagram Development, MDS Diagram, Generation, Synchronizing Two System And Choosing Controller, Architecture, State Assignment, Next State Decoders And Its Maps, Output Decoders, Clock And Power Supply Requirements, MSI Decoders, Multiplexers In System Controllers, Indirect Addressed Multiplexers Configurations, Programmable System Controllers, ROM, PLA And PAL Based Design. Introduction to the CPLD & FPGA.

## SECTION D

**Asynchronous Finite State Machines:** Scope, Asynchronous Analysis, Design Of Asynchronous Machines, Cycle And Races, Plotting And Reading The Excitation Map, Hazards, Essential Hazards Map Entered Variable, MEV Approaches To Asynchronous Design, Hazards In Circuit Developed By MEV Method.

Text Books:

1. Fletcher, "An Engineering Approach to Digital Design", PHI 1990
2. Z. Kohavi, "Switching and Finite Automata Theory", TMH

### Reference Books

1. Markovitz, "Introduction to Logic Design", TMH
2. Mano, "Digital Design", PHI

NOTE: For setting up the question paper, Question No. 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.

16ECE22D2

## IMAGE PROCESSING

L T P

4 - -

Marks Credits

Exams : 100 4

Sessionals : 50

Total : 150 4

Duration of Exam : 3 hrs.

**Course Outcomes** : After this course students shall be able to

CO1: Review the fundamental concepts of a digital image processing system.

CO2: Analyze images in the frequency domain using various transforms.

CO3: Evaluate the techniques for image enhancement and image restoration.

CO4: Categorize various compression techniques.

CO5: Interpret Image compression standards.

### SECTION A

**Introduction:** Elements of Digital Image Processing Systems, Image Acquisition, Storage, Processing Communication Display.

**Digital Image Fundamentals:** Visual Perception, simple image models, concept of uniform and nonuniform sampling & quantization, Relationships between pixels-neighbors of pixel, connectivity labeling of connected components. Relations, equivalence and Transitive closure, Distance measures, Arithmetic/ Logic operation, Imaging Geometry Basic and perspective transformation stereo imaging.

### SECTION B

**Image Transforms:** Discrete Fourier transform, 2-D Fourier Transforms and its properties. Fast Fourier transform and its uses. Walsh, Hadamard Discrete cosine, Heir and slant transforms hostelling their algorithms and computer implementations.

**Image Enhancement:** Spatial and frequency domain methods point processing, intensity transformation, Histogram processing image subtraction and Averaging spatial filtering, LP, HP and homo- morphic felling, generation of spatial marks, Color image processing.

### SECTION C

**Image Restoration:** Degradation model, digitalization of circulate and block circulate metrics, Algebraic approved invoice filtering, wiener filter, constrained least square restoration, Interactive restoration in spatial domain geometric transformation.

**Image Compression:** Redundancy models, error free compression, Lossy compression, Image compression standards.

### SECTION D

**Image Segmentation:** Detection of Discontinuity, Edge detection, Boundary detection, Thresholding, Regional oriented segmentation use of motion in segmentation.

**Representation and Description:** Image analysis, Pattern and their classes, Decision theoretical methods, Structural methods, Interpretation.

#### Text Books:

1. Anil K Jain, "Fundamentals of Digital Image Processing", PHI Edition 1997.
2. Keenneth R Castleman, "Digital Image Processing", Pearson

#### Reference Books:

1. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Pearson
2. Chanda & Majumder, "Digital Image Processing & Analysis", PHI

**NOTE: For setting up the question paper, Question No. 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.**

## 16ECE22D3 ADVANCED MATHEMATICS FOR ENGINEERS

L	T	P	Marks	Credits
4	-	-	Exams : 100	4
			Sessionals : 50	
			Total : 150	4
			Duration of Exam : 3 hrs.	

**Course Outcomes** : After the course students shall be able to

CO1: Analyze the fundamental concepts of Fourier Transform and Z-Transform and their applications.

CO2: Evaluate the exact and numerical methods for solution of Linear system of Equations.

CO3: Interpret the Conformal mapping and their properties for function of complex variables.

### SECTION A

**Fourier Transforms:** Introduction, Fourier Integral Theorem, Fourier Sine and Cosine Integral, Complex form of Fourier Integrals, Fourier Transforms, Inverse Fourier Transform, Properties, Modulation Theorem, Convolution Theorem for Fourier Transforms, Parseval's Identity, Fourier Transforms of derivative of functions, Relation between Fourier and Laplace transform.

### SECTION B

**Z –Transform** : Introduction, Properties of Z- Transform, Evaluation of inverse Z – Transform.

### SECTION C

**Matrices And Linear System Of Equations:** Solution of linear simultaneous equations by Gaussian elimination and its modification, Crout's triangularization method, Iterative methods- Jacobi method, Gauss-Seidel method, Determination of Eigen values by iteration.

### SECTION D

**Conformal Mapping:** Conformal mapping, linear transformations, Bi-linear transformations, Schwarz's-Christoffel transformations.

**Calculus Of Variations:** Euler-Lagrange's differential equation, The Brachistochrone problems and other applications. Isoperimetric problem, Hamilton's Principle and Lagrange's Equation. Rayleigh-Ritz method, Galerkin method.

### Text Book:

1. Dr. B.S. Grewal; "Higher Engineering Mathematics", Khanna Publishers
2. Churchill, "Fourier Series and Boundary Value Problems", McGraw Hill.
3. Gelfand & Fomin, "Calculus of Variations", Prentice Hall.

### Reference Books:

1. Churchill, "Complex Variables & Applications", McGraw Hill.
2. Elsgole, "Calculus of Variations", Addison Wesley.

3. I.N.Sneddon."TheUseofIntegralTransforms",TataMcGraw Hill.

**NOTE: For setting up the question paper, Question No. 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.**

**GURUGRAM UNIVERSITY**  
**SCHEME OF STUDIES AND EXAMINATION**  
**M.TECH 2nd YEAR (ELECTRONICS & COMMUNICATION ENGINEERING)**  
**SEMESTER 3rd**

Sl. No	Course No.	Subject	Teaching Schedule				Examination Schedule (Marks)				Duration of Exam (Hours)	No of Credits
			L	T	P	Total	Marks of Class works	Theory	Practical	Total		
1	17ECE23C1	Neural Networks & Fuzzy Logics	4	0	-	4	50	100	-	150	3	4
2	17ECE23C2	CDMA	4	0	-	4	50	100	-	150	3	4
3	17ECE23C3	DISSERTATION (PHASE-I)	-	-	-	4	100	-	-	100		2
4	17ECE23C4	Seminar	-	-	-	2	50	-	-	50		2
5	17ECE23CL1	Project	-	-	2	2	50	-	50	100		2
6	17ECE23CL2	MATLAB Lab	-	-	2	2	50	-	50	100		2
7		OPEN ELECTIVE										3
		<b>TOTAL</b>										<b>21</b>

NOTE:



- 1. Students will be allowed to use non-programmable scientific calculator. However, sharing of Calculator will not be permitted in the examination.**
- 2. Students have to publish a research paper in a journal / conference on the basis of literature survey done in the semester.**

OPEN ELECTIVE: A candidate has to select this paper from the pool of open electives provided by the University.

GURUGRAM UNIVERSITY  
 SCHEME OF STUDIES AND EXAMINATION  
 MTECH 2nd YEAR (ELECTRONICS & COMMUNICATION ENGINEERING)  
 SEMESTER 4th

Sl. No	Course No.	Subject	Teaching Schedule				Examination Schedule (Marks)				No of Credits
			L	T	P	Total	Marks of Class works	Theory	Practical	Total	
	17ECE24C1	Dissertation and viva	-	-	-	-	250	-	500	750	<b>20</b>
		<b>TOTAL</b>	-	-	-	-	<b>250</b>	-	<b>500</b>	<b>750</b>	
		<b>GRAND TOTAL</b>									

NOTE:

- Students have to publish a research paper in a journal / conference of the research work done in the semester.**

**17ECE23C1**

**NEURAL NETWORKS & Fuzzy Logics**

L T P  
4 - -

	Marks	Credits
Exams	: 100	4
Sessionals	: 50	
Total	: 150	4
Duration of Exam	: 3 hrs.	

**Course Outcomes:**

CO1. To Expose the students to the concepts of feed forward neural networks

CO2. To provide adequate knowledge about feedback networks.

CO3. To teach about the concept of fuzziness involved in various systems. To provide adequate knowledge about fuzzy set theory.

CO4. To provide comprehensive knowledge of fuzzy logic control and adaptive fuzzy logic and to design the fuzzy control using genetic algorithm.

CO5. To provide adequate knowledge of application of fuzzy logic control to real time systems.

### **SECTION A**

**Introduction:** Neural networks characteristics, History of development in neural networks principles, Artificial neural net terminology, Model of a neuron, Topology.

### **SECTION B**

**Learning Methods & Neural network models:** types of learning, Supervised, Unsupervised, Re-inforcement learning. Knowledge, representation and acquisition. Basic Hop field model, Basic learning laws, Unsupervised learning, Competitive learning, K-means clustering algorithm, Kohonen's feature maps.

### **SECTION C**

**Artificial Neural Networks:** Radial basis function neural networks, Basic learning laws in RBF nets, Recurrent back propagation. Introduction to counter propagation networks, CMAC network, and ART networks.

### **SECTION D**

**Fuzzy Logic:** Basic concepts of fuzzy logic, Fuzzy vs. Crisp set, Linguistic variables, Membership functions, Fuzzy sets & Operations of fuzzy sets, Fuzzy IF- THEN rules, Variable inference techniques, De-Fuzzification, Basic fuzzy inference algorithm, Fuzzy system design, Industrial applications.

#### **Text Books:**

1. B. Yegnanarayana, " Artificial Neural Networks"PHI
2. J.M. Zurada, "Introduction to artificial neural systems", Jaico Pub.
3. ROSS J.T , "Fuzzy logic with engineering application", TMH

#### **Reference Books:**

1. Simon Haykin, "Neural Networks", PHI
2. Ahmad M.Ibrahim, "Introduction to applied Fuzzy Electronics", (PHI)
3. P.D. wasserman , "Neural computing theory & practice", (ANZA PUB).

**NOTE: For setting up the question paper, Question No. 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.**

**17ECE23C2**

**CDMA SYSTEMS**

L	T	P	Marks	Credits
4	-	-	Exams : 100	4
			Sessionals : 50	
			Total : 150	4
			Duration of Exam : 3 hrs.	

**Course Outcome :-** The students shall have

CO1. Gained the fundamental knowledge about Planning of CDMA cellular communication in designing and optimization.

CO2. Learned futuristic version of CDMA. Will benefit as system engineer in cellular technology.

CO3 learnt about CDMA transmitter and receiver and their desired characteristics

**SECTION A**

Direct sequence and frequency hopped spread spectrum, spreading sequence and their correlation functions, Acquisition and tracking of spread spectrum signals.

**SECTION B**

Error probability for DS-CDMA, on AWGN channels, DS- CDMA on frequency selective fading, channels, Performance analysis of cellular CDMA

**SECTION C**

Capacity estimation, Power control, effect of imperfect power control on DS CDMA performance, Soft Handoffs.

**SECTION D**

Spreading /coding tradeoffs, multi-carrier CDMA, IS-95 CDMA system, third generation CDMA systems, multi-user detection.

**Text Books:**

1. Andrew J. Viterbi, "CDMA Principles of spread spectrum communications", Addison Wesley 1995.
2. J.S. Lee and L.E. Miller, "CDMA system Engineering handbook", Artech house 1998.

**Reference Books:**

1. Garg, "CDMA : 2000 : Cellular/ PCS system Implementation", Pearson
2. Steve Lee, "Spread spectrum CDMA", TMH

NOTE: For setting up the question paper, Question No. 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.

**17ECE23C3**

**DISSERTATION (PHASE-I)**

L	T	P	Marks	Credits
-	-	4		
			Exams :	
			Sessionals :	100
			Total :	100    2
			Duration of Exam :	3 hrs.

Every student will carry out dissertation under the supervision of a Supervisor(s). The topic shall be approved by a Committee constituted by the Head of the concerned Deptt.

Every student will be required to present two seminar talks, first at the beginning of the Dissertation (Phase-I) to present the scope of the work and to finalize the topic, and second towards the end of the semester, presenting the work carried out by him/her in the semester. The committee constituted will screen both the presentations so as to award the

sessional grades out of A+, A, B, C, D and E. A student scoring 'F' grade shall have to improve this grade before continuing his/her Dissertation in the 4<sup>th</sup> semester failing which he/she shall have to repeat the Dissertation (Phase-I) next time in the regular 3<sup>rd</sup> semester

#### COURSE OUTCOMES:

By the end of this course every student is expected to be able to

CO1 understand the process of research.

CO2 do literature survey to identify a research problem.

CO3 communicate and discuss research ideas.

CO4 plan and write dissertation synopsis.

L	T	P	Marks	Credits
-	-	2	Sessional : 50	2
			Total : 50	2

Every student will be required to present a seminar talk on a topic approved by the Deptt. except on his/her dissertation. The committee constituted by the Head of the Deptt. will evaluate the presentation and will award one of the grades out of A+,A,B,C,D and E.

A Student who is awarded the 'F' grade will be required to repeat the seminar on the same topic.

At the end of this course the student shall be able to

CO1 prepare the topic and contents on a technical topic

CO2 speak on a technical topic effectively

CO3 enhance communication skills



17ECE23CL2

MATLAB Lab

L T P

Total Credits: 2

- - 2

Course Outcomes:

By the end of this course the students will have

CO1 Ability to express programming & simulation for engineering problems.

CO2 Ability to find importance of this software for Lab Experimentation.

CO3 Articulate importance of software's in research by simulation work.

CO4 In-depth knowledge of providing virtual instruments on LabVIEW Environment.

CO5 Ability to write basic mathematical ,electrical ,electronic problems in Matlab.

CO6 Ability to simulate basic electrical circuit in Simulink.

**UNIT 1 MATLAB FUNDAMENTALS:** Introduction, platforms and versions, launching MATLAB, window, help features, types of file, creating directory and saving files, notation, syntax and operations, constants, variables and expression, some built in function, commands, problems.

**UNIT 2 VECTORS & MATRICES:** Addition, subtraction, multiplication, vector products and transpose, commands, problems.

**UNIT 3 MATLAB PROGRAMMING:** Input-Output Statements: data input, interactive input, output command. Programming in M files, script and function files, variables, data types, operators, control structures

**UNIT 4 GRAPHICS USING MATLAB:** Creating plots, 2-D, 3-D, multiple plots, editing plots, visualizing function of two variables, image Printing graphics, handle graphics, GUI, problems.

**UNIT 5 INTRODUCTION TO TOOLBOXES:** The symbolic math toolbox, control system toolbox, signal processing toolbox, communication toolbox, MATLAB applications, animation, problems.

**UNIT 6 SIMULINK BASICS:** Introduction, simulink model editor, simulink library, blocksets, running a simulation, building simple model, problems with models.

**Reference Books:** 1. MATLAB and its Applications in Engineering, Raj Kumar Bansal, Ashok Kumar Goel, Manoj Kumar, Pearson Education.

2. Partha S Mallick, Matlab and Simulink: Introduction to Applications, 2nd edi, SCITECH.

3. K K Mishra, Numerical Technique Lab Matlab Based Experiments, I K international publishing house. NOTE: At least 10 experiments are to be performed by students in the semester as per the

**17ECE24C1**

**DISSERTATION**

L T P  
- - 20

Marks Credits

Sessionals : 250

Practical Exam : 500

Total : 750 20

Duration of Exam. : 3 hours.

The Dissertation Phase-1 will be continued as dissertation in 4<sup>th</sup> Semester. The award of sessional grades out of A+, A, B, C, D and E will be done by an internal Committee constituted by the Head of the Deptt.

This assessment shall be based on presentation (s), report, etc. before this committee. In case a student scores 'F' –grade in the sessional, failing which he/ she will not be allowed to submit the dissertation.

At the end of the semester, every student will be required to submit three bound copies of

his/her Master's dissertation of the office of the concerned Department. Out of these, one copy will be kept for department record & one copy shall be for the supervisor. A copy of the dissertation will be sent to the external examiner by mail by the concerned department, after his/her appointment and intimation from the university. Dissertation will be evaluated by a committee of examiners consisting of the Head of the Department, dissertation supervisor(s) and one external examiner. There shall be no requirement of a separate evaluation report on the Master Dissertation from the external examiner.

The external examiner shall be appointed by the University from a panel of examiners submitted by the respective Head of Deptt., to the Chairman, Board of Studies. In case the external examiner so appointed by the University does not turn up, the Director/ Principal of the concerned college, on the recommendation of the concerned Head of the Deptt. Shall be authorized, on behalf of the University., to appointed an external examiner from some other institution.

The student will defend his/her dissertation through presentation before this committee and the committee will award one of the grades out of A+, A, B, C, D and E Student scoring 'F' grade in the exam shall have to resubmit his/her Dissertation after making all correction

/ improvements and this dissertation shall be evaluated as above. **Note:** The Scheme of awarding the Grades to the student in the course will be supplied by the University to the examiner(s).

#### COURSE OUTCOMES:

By the end of this course every student is expected to be able to

CO1 handle research problems and use modern research tools/methods.

CO2 analyse and review the existing literature on a research problem.

CO3 design and conduct experiments.

CO4 write dissertation and technical reports.

CO5 publish research papers.