L: 3	**ET 761 Analog System Design**
T: 1	**Theory: 100 marks**
P: 0	**Sessional: 75 marks**
	Time: 3 hours

Operational Amplifier Fundamentals

Introduction. Op-amp configurations, ideal Op-amp circuit analysis, negative feedback Non-ideal closed loop characteristics. Powering the Op-amp.

Linear Op-amp Circuit

DC sources, current to voltage converters, V-I converters (floating load and grounded load). Current amplifiers.

Non-linear Circuit Applications

Comparators. Applications. Level detectors. Window detectors. Schmitt trigger. Precision half wave and full wave rectifiers Peak detectors. Sample and hold circuits.

Signal Generators

Sine wave generators. mono-stable. bi-stable and astable multivibrators and their Applications. Triangular wave generator triangular to sine- wave converter sawtooth generator. Voltage to frequency and frequency to voltage converters.

Limitations of Practical Op-amps

DC performance - Bias. offset and drifts-input bias and offset current, effects of offset current on output voltage; input offset voltage Offset error compensation AC performance- frequency response, frequency compensation, bandwidth limitation, slew rate and slew rate limitation. Noise considerations.

Voltage Reference

Performance parameters. Zener and Avalanche diode voltage references. Drift due to temperature change. Compensation methods. Applications.

Voltage Regulators

Series regulators. Building blocks IC Voltage Regulators-applications. Thermal considerations. Power supply design.

D/A and A/D converters

Converter definitions and specifications. Basic DAC techniques. Bipolar DACs. DAC based AD converters. Flash/Parallel converters. Integrating type ADCs Data acquisition and distribution.

Active Filters

First order active filters. Audio filter application. Second order low-pass, high-pass, band pass and notch filters. Butterworth filters. Cascaded design. RLC simulation design. Filter sensitivity.

Logarithmic Amplifiers and Analog Multipliers

Log/Antilog Amplifier. Practical Log/Antilog circuits. Non-linear function circuits. Analog multipliers.

Text Books/references:

1. Sergio Franco - Design with Operational Amplifiers and Analog Integrated Circuits, McGraw Hill Book Company.

2. R.F. Coughlin, F.F. Driscoll - Operational Amplifier and Linear Integrated Circuits, Prentice Hall of India

L: 3	ET 762 Computer Architecture Organization
T: 1	Theory: 100 marks
P: 0	Sessional: 75 marks
	Time: 3 hours

Evolution of Computer

Introduction, different generations till the present time. Basic structure of a computer.

Design Methodology

Components and design techniques at gate level, resistor level and processor level. Processing Unit of a Computer.

Processor organization

Number formats. Instruction formats, instruction types. Fixed point arithmetic, addition, subtraction, division and multiplication.

ALU

Organization floating point arithmetic, arithmetic processor.

Control Unit

Instruction sequencing and interpretation. Control unit design.

Memory Organization

Types of memories. Memory device characteristics. RAM organization. Memory hierarchies. Cost and performance Virtual memories. High speed memories like caches.

Parallel Processing

Introduction and types of parallel processors with performance considerations. Pipe-line processors and multiple processors.

Text Books / references:

1. John P Hayes - Computer Architecture & Organization, Mc Graw Hill Book Company.

2. M. Mano - Computer System Architecture, Prentice-Hall of lndia.

L: 3	**ET 763 Digital Signal Processing**
T: 1	**Theory: 100 marks**
P: 0	**Sessional: 75 marks**
	Time: 3 hours

Discrete time signals and systems

Signal and system classification, time and frequency domain representation.

Discrete time signal analysis and linear systems

Linear time invariant system. Linear time invariance. Unit impulse system response. Causality, stability, IIR and FIR systems. Difference calculations and its solutions. Fourier transforms, frequency response, linear phase system. Sampling of analog signals.

Z-transforms and its properties

Analysis of LTI systems in Z-transform.

Realization of digital systems

Recursive and non-recursive structures. Block diagram and signal flow graphs Direct cascade, parallel, ladder and lattice realization.

Design of IIR digital filters

Approximation theory impulse invariance and bilinear transformations. Frequency transformations. Computer aided design techniques.

Design of IIR digital filters

Windowing and frequency sampling techniques. Computer aided design methods.

Discrete Fourier transforms

Discrete time Fourier series. Discrete time Fourier transforms. Properties, circular convolution and computation of DFT.

FFT algorithm

Basic D-I-T and D-I-F algorithms Computational efficiency considerations.

Finite word length effects

Quantization errors and their effects on performance of digital signal processor.

Digital signal processing applications

Introduction to image processing, speech and audio processing.

Text Books / references:

1. A.V. Oppenheim and R.W. Schafer - Discrete Time Signal Processing, Prentice-Hall of India.

2. J. G. Proakis and D.G. Manolakis - Digital Signal Processing: principles, Algorithms and Applications, Prentice-Hall of India.

3. Alkin - Digital Signal Processing : A Laboratory Approach using PC-DSP, Prentice-Hall of India.

4. MATLAB User's Guide, Math Works Inc.

L: 3	ET 764 Mobile Communications
T: 1	Theory: 100 marks
P: 0	Sessional: 75 marks
	Time: 3 hours

Introduction to Wireless Communications
The wireless vision. Applications and requirements. The obstacles and challenges. A brief historical tour. Standards. Spectrum regulation and de-regulation. Classification of wireless systems. The cellular concept and its guiding principles. Frequency reuse. Handoff. Some essentials on traffic theory.

Antennas & Propagation
Antenna fundamentals. Radiation patterns, gain and effective area. Reciprocity. Friis formula. Free-space propagation. Ray tracing. Empirical models. Large-scale path loss. Shadow fading. Cell coverage and outages.

The Mobile Radio Channel
Multipath propagation and fading. Doppler spectrum and coherence time. Slow and fast fading. Narrowband signals. Stationarity. Power angular spectrum and correlation. Fading distributions: Rayleigh, Ricean and Nakagami. Level crossing rates and average fade durations.

Wideband Radio Channels
Frequency-selective fading. Coherence bandwidth. Delay spread and intersymbol interference. Equalization. OFDM.

Channel Capacity
Basic information theory notions. Shannon's coding theorem. Capacity. Side information. Capacity of AWGN and faded channels. Rate adaptation. Capacity of frequency-selective channels.

Diversity
Concept of diversity. Macroscopic and microscopic diversity. Diversity mechanisms: frequency, time, space, polarization and pattern. Diversity combining: selection, equal-ratio combining and maximal-ratio combining. Performance. Transmit diversity.

Spread Spectrum
Spread spectrum principles. Directe-sequence spread spectrum. RAKE receivers. Frequency-hopping spread spectrum.

Multiple Access
Multiuser channels: uplink and downlink. Multiple access schemes: orthogonal (FDMA, TDMA and OFDMA) and non-orthogonal (CDMA and SDMA).

Text books / references:

1. Andrea Goldsmith – Wireless Communications, Cambridge University Press, 2005.

2. David Tse and Pramod Viswanath – Fundamentals of Wireless Communication, Cambridge University Press, 2005.

3. John Proakis – Digital Communication, McGraw-Hill.

4. W. C. Y. Lee - Mobile Communication Design Fundamentals, John Wiley and Sons, 1993, 2/e.

5. T. S. Rappaport - Wireless Communication, Prentice Hall, 1996.

6. W. C. Y. Lee - Mobile Cellular Telecummunications, McGraw - Hill, 1995, 2/e.

7. G. H. Stubber - Principles of Mobile Communications, Kluwer, 1996.

L: 3	**ET 765 Integrated Circuit Technology**
T: 1	**Theory: 100 marks**
P: 0	**Sessional: 75 marks**
	Time: 3 hours

Basic Outline of fabrication techniques; Silicon bipolar transistor as an example. Cost benefits of mass produced circuit blocks, reliability and performance considerations. Disadvantages. Exploiting the inherent component matching capabilities of I.C.s - example from linear and digital circuits.

Introductory ideas about crystal growth and wafer preparation. Short description of the Czochralski process.

The diffusion process. Simple diffusion theory and the evaluation of impurity diffused in silicon - determination of junction depth and sheet resistance. Oxidation and epitaxial growth of silicon. Pre-deposition and drive-in diffusions in junction devices. Fick's law, distribution of impurities and the calculation of emitter and base depths. Lateral diffusion. Diffusion related parameters for boron and phosphorous. Preparation of a simple process schedule.

Lithography. Optical lithography, minimum line-width consideration, layout fundamentals and mask making. Brief references to X-ray, electron beam and deep UV lithography.

Interconnection. Aluminium metallization -- resistance heated evapovated and CVD methods. Brief mention about metallization failures -- step covering and electromigration. Other method of interconnection.

Passive components. MOS capacitors and resistors. Calculation of area and the layout of capacitors and resistors.

NMOS and CMOS fabrication techniques. Polysilicon self aligned gate devices. Layout of simple Circuits. Introduction to VLSI processing and layout Stick diagrams and layout and simulation tools.

Other related processes. Ion implantation, dry etching, sputtering, assembly and reliability related evaluation. Future trends.

Text Books / references:

1. Douglas J. Hamilton and William G. Howard - Basic Integrated Circuit Engineering, McGraw-Hill Book Company.
2. S M. Sze - Basic VLSI Technology. McGraw-Hill Book Company
3. Douglas A. Pucknell and Karman Eshraghain - Basic VLSI Design, Prentice Hall of India.
4. Andrew S. Grove - Physics and Technology of Semiconductor Devices, John Wiley and Sons.
5. R Jacob Baker, Harry W. Li and David E. Boyce - CMOS circuit design layout and simulation,PHI.

L: 3	**ET 765 Communication System Engineering**
T: 1	**Theory: 100 marks**
P: 0	**Sessional: 75 marks**
	Time: 3 hours

Review of AM and FM broadcasting systems.
Transmitter and receiver circuits and structures.

Television (Black and White)
Signal structure of composite \ video signal. Sound subcarrier. VSB broadcasting and reception. Sound demodulation. Camera and imaging devices. Scanning and deflection circuits.

Colour Television
Colour video signal. Colour modulation svstems PAL, SECAM and NTSC. Transmission and reception. Colour signal recovery. Colour representation in vector space.

Digital Audio and DAB
Principles and formats Important considerations such as encoding and compression. Framing and multiplexing issues and standards.

Telephony
Analogue and Digital. Principles and standards. Principles of facsimile and paging.
Introduction to advanced communication systems

Channel coding and transmission over terrestrial, satellite and networks.

Text Books / references:

1. R. R Gulati - Colour Television Principles and Practice, Wiley Eastern Pvt. Ltd.
2. A. M. Dhake - Television and Video Engineering, Tata McGraw Hill.
3. R. L Freeman - Telecommunication Systems Engineering, John Wiley and Sons.
4. R. G. Winch - Telecommunication Transmission Systems, McGraw-Hill Book Company.
5. W. C. Y. Lee - Mobile cellular Communications, McGraw-Hill Book Company.
6. Wayne Tomasi - Electronic Communications Systems, Pearson Education Asia.
7. Harold Kolimbiris - Digital Communication Systems, Pearson Education Asia.
8. H. L. Rohde - Communication Receivers, McGraw-Hill Book Company.

L: 3	ET 765 Optimization Techniques
T: 1	Theory: 100 marks
P: 0	Sessional: 75 marks
	Time: 3 hours

Introduction to optimization

Introduction and scope of optimization. Definitions: design vector, design constraint and objective function. Classification of optimization problems.

Classical optimization techniques

Local and global minima and maxima. Single and multi-variable optimization without constraints. Multivariable optimization with inequality constraints. Method of direct substitution and method of Lagrange's multipliers. Multivariable optimization with inequality constraints. Kuho-Tucker conditions.

Linear programming

Formulation of linear programming problems (LPP). Standard form of LPP. Geometry of LPP (graphical solution). Solution by the simplex method. Computer program. Duality in linear programming. Sensitivity or post-optimality analysis.

Non-linear programming

Uninodal functions. One dimensional minimization methods. A brief idea about elimination (search) method. Fibonacci and golden section methods. Quadratic interpolation method. Gradient methods. Method of steepest descent, conjugate gradient (Fletcher-Reeve) method.

A brief introduction to dynamic programmiry and solution to simple problems.

Text Books / references:

1. N. S Rao - Optimization: Theory and Application Wiley Eastern ltd.

2. H. Taw - Operations Research - An Introduction, Prentice Hall

3. K. V. Mittal and C. Mohan - Optimization Methods in Operations Research and System Analysis, New Age International.

L: 3	**ET 765 Micro Electro Mechanical Systems**
T: 1	**Theory: 100 marks**
P: 0	**Sessional: 75 marks**
	Time: 3 hours

Introduction: Historical background, development of microelectronics, evolution of micro sensors, MEMS, emergence of micro machines. Electronic materials and processing: Introduction, electronic materials and their deposition, pattern transfer, etching electronic materials, doping semiconductors.

MEMS Materials and Processing: Overview, metals, semiconductors, ceramic, polymeric and composite materials. Silicon micro machining – bulk: Introduction, etch-stop techniques, dry etching, buried oxide process, silicon fusion bonding, anodic bonding.

Silicon Micro Machining–Surface: Introduction, sacrificial layer technology, material systems in sacrificial layer technology, plasma etching, combined IC technology and anisotropic wet etching.

Micro Sensors: Introduction, thermal sensors, radiation sensors, mechanical sensors, magnetic sensors, biochemical sensors and flow sensors. SAW Devices: Introduction, saw devices development and history, transducers in SAW devices, acoustic waves.

Micro Sensors: LIGA – Introduction, Application of LIGA, Technology barrier and competing technologies, Microsterolithography – Introduction, Scanning method, two photon MSL, Projection MSL, Polymeric MEMS Architecture with silicon, Metal and ceramics, Applications of MSL.

Text Books/ References:

1. S.M.Sze - Semiconductor Sensors, John Wiley & Sons, Inc., 1994.
2. M.Elwenspoek, R.Wiegerink - Mechanical Microsensors, Springer-Verlag Berlin Heidelberg, 2001.
3. Julian W. Gardner, Vijay K. Varadan - Microsensors, MEMS, and Smart Devices, John Wiley & Sons Ltd, 2001.
4. Massood Tabib-Azar - Microactuators - Electrical, Magnetic, Thermal, Optical, Mechanical, Chemical and Smart structures, Kluwer Academic Publishers, New York, 1997.
5. Eric Udd - Fiber Optic Smart Structures, John Wiley & Sons, New York, 1995.
6. Kevin Chau - Analog Devices, Inc., Introduction to MEMS Technology and Devices (SC266), SPIE education services, Bellingham WA.
7. Vasundara Varadan, Vijay Varadan - Microsensors and MEMS for Smart Structures

L: 3	**ET 766 Telecommunications Switching and Transmission Systems**
T: 1	**Theory: 100 marks**
P: 0	**Sessional: 75 marks**
	Time: 3 hours

Introduction

Review of circuit and packet networks. Switching systems. Telecommunication transmission networking and media selection (fiber optics, cable, wireless) theory and practices. Network configuration and network technologies.

Network services and architecture

Top down, application-driven view of networks, including a layered approach.

Networks

Packet networks, OSI model, packet switching, Internet. Circuit networks, core and access technologies, circuit switching and intelligent networks. ATM networks. Network control and operations, quality of service.

Wireless systems

Cellular system. Wireless LANs.

Optical systems

Components of optical system. WDM, optical routing and all-optical networks

Text Books / references:

1. L. W. Couch II, "Digital and Analog Communications Systems", 6th edition, Prentice Hall, 2001.

2. M. Schwartz, "Telecommunications Networks: Protocols, Modeling and Analysis", Addison Wesley.

3. W. Stallings, "Data and Computer Communications", 6th edition, Prentice Hall, 2000.

4. A. S. Tanenbaum, "Computer Networks", 2nd edition, Prentice Hall, 1989.

5. T. S. Rappaport, "Wireless Communications: Principles and Practice", Second Edition, Prentice Hall, 2002.

6. K. Pahlavan and P. Krishnamurthy, "Principles of Wireless Networks", Prentice Hall, 2002.

7. Rajiv Ramaswami and Kumar N. Sivarajan, "Optical Networks: A Practical Perspective", 2nd edition, Morgan Kaufmann, 2002.

8. Thomas E. Stern and Krishna Bala, "Multiwavelength Optical Networks: A Layered Approach", Addison Wesley, 2000.

L: 3	**ET 766 Multimedia Theory and Applications**
T: 1	**Theory: 100 marks**
P: 0	**Sessional: 75 marks**
	Time: 3 hours

Introduction

History of Multimedia Systems, Hypermedia/Multimedia, HyperText/HyperMedia, Overview of Multimedia Software Tools, Music Sequencing and Notation, Graphics Image and Video Editing, Multimedia Authoring.

Issues in Multimedia authoring

Multimedia Authoring Metaphors, Content Design, Scripting(Writing), Graphics(Illustrating), Animation(Wiggling), Audio(Hearing), Interactivity (Interacting)

Multimedia Data Representations

Basics of Digital audio, Introduction to MIDI(Musical Instrument Digital Interface), Graphics/ Image File Formats, Standard System Independent Formats, System Dependent Formats, Color in Image and Video, Basics of Video, Types of Color Video Signals, Digital Video.

Video and Audio Compression

Basics of Information Theory, Lossless Compression Algorithms, Huffman Coding, Lempel-Ziv-Welch Algorithm, Image Compression-JPEG, 4 JPEG modes, JPEG 2000, Video Compression, H.261, H.263, MPEG, New MPEG Standards, Audio Compression, Simple Audio Compression Methods, Psychoacoustics.

Text Books/ References

1. Multimedia System Design by Adeleigh and Thakrar.
2. Multimedia at Work by T. Vaughan
3. Introduction to Data Compression by Khalid Sayood

L: 3	**ET 766 Acoustics and Sound Engineering**
T: 1	**Theory: 100 marks**
P: 0	**Sessional: 75 marks**
	Time: 3 hours

Fundamentals of Acoustics: Nature of sound and the physics of vibrations. Wave equations and wave propagation. Plane and spherical sound waves. Sound pressure and intensity. Propagation effects – attenuation and dispersion. Acoustic impedances. Noise absorption and insulation. Measurement of sound level. Perception of sound level and direction. Frequency response of the ear. Standard weighting curves and reference levels for sound measurement. Techniques for measuring sound level. Laws and standards for environmental noise. Health and safety aspects.

Sound Production - Vibrations and Resonators: Vibration of mechanical systems. Wave propagation through various media and boundaries. Resonance. Sound waves in pipes. Helmholtz resonators. Musical instruments. Analogies between acoustic, electrical and mechanical systems.

Loudspeakers, Microphones, Psychoacoustics and Sound Reproduction: Pressure and velocity microphones. Directional and frequency response of microphones. Operational details and properties of various types of microphones: moving coil, ribbon, capacitor, electrostatic. Operation of moving coil loudspeakers. Design of different types of loudspeaker enclosures (infinite baffle, tuned port, acoustic suspension, horn). Psychoacoustic effects and their applications in sound perception. Sound reproduction, Dolby noise reduction, mini-disk, surround sound. Compare and contrast Dolby A, SR and DBX noise reduction. Identify when and how to use noise gates. Near/field and far/field monitoring. Principles of loud speaker system's proper selection and placement in the control room. Loudspeaker phase linearity.

Acoustics in Enclosed Spaces: Sound in rectangular enclosures: time and frequency analysis. Direct and reflected sound. Diffuse sound fields. Normal modes of vibration in regular enclosures. Transient responses. Reverberation. Statistical characterization of sound in irregular enclosures. Calculation and measurement of reverberation. Reverberation time and other design criteria. Architectural acoustics. Speech and communication in enclosed spaces. Sound transmission through walls.

Principles of Audio Recording: Physical properties of analog tape. Analog tape recording process. Analog tape formats and equipment from visuals. Cleaning and demagnetization of different analog tape machines. Principles of the digital recording process. Digital audio editing. Digital recording machines of differing formats and storage types from visuals. Compare/Contrast the difference between preamplifiers and power amplifiers. Identify and place preamplifiers in the audio signal chain. Identify and place power amplifiers in the audio signal chain, define equalizers, summing amplifiers, distribution amplifiers, isolation amplifiers, impedance amplifiers, power amplifiers, voltage controlled amplifiers.

MIDI: Applications of MIDI controllers, voice modules, and sequencers. Principles of synchronization and equipments used for synchronization. Procedures for implementing synchronization principles and
equipment.

Fundamentals of Signal Processing: Amplitude and wave shape processing. Audio equipment used to manipulate the amplitude and wave shape of audio signals. Compression, limiting, expansion, keying, and ducking. Compressor and dynamics processing equipment. Fundamental controls of dynamics processors.
Application of delays, artificial reverberation and the other types of enhancers that are used in contemporary audio production.

Skills to Plan a Recording Session: Pprocedures of Recording, Overdubbing, Mixdown, Editing. Identify the needs of the client given a simulated recording project. Planning and tracking a recording session. Studio and setup equipment for a recording session.

Books / references :

1. Kinsler, Frey, Coppens and Saunders: Fundamentals of Acoustics, Wiley. 2000.

2. D E Hall: Basic Acoustics, Wiley. 1987.

3. T. D. Rossing, F. R. Moore, and P. A. Wheeler: The Science of Sound, Pearson Addison- Wesley, 2001.

4. Bruce and Jenny Bartlett: Practical Recording Techniques. Focal Press, 3rd edition. 2001.

L: 0	**ET 767 Training**
T: 0	**Total Marks: 50**
P: 2	

Industrial training in a recognized organization.

L: 0	**ET 768 Project I**
T: 0	**Total Marks: 100**
P: 8	

Project on any of the following topics:

1. Digital System Design
2. Antenna
3. Communication
4. VLSI
5. Digital Signal Processing
6. Digital Image Processing
7. Microprocessor
8. Robotics
9. Mobile Communication
10. Microwave
11. Optical Fiber Communication
12. Modeling & Simulation