MICROPROCESSORS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV (EC/TC)

Subject Code	15EC42	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to:

- Familiarize basic architecture of 16 bit and 32 bit microprocessors.
- Program 8086 Microprocessor using Assembly Level Language
- Use Macros and Procedures in 8086 Programs
- Understand interfacing of 16 bit microprocessor with memory and peripheral chips involving system design.
- Program 8087 Coprocessor and use its instructions in the program.
- List the features of various high speed buses and higher bit processors

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
8086 PROCESSORS: Historical background, The microprocessor based personal computer system, Van-Neumann and Harvard Architecture, RISC & CISC processor architecture, 8086 CPU Architecture, Machine language instruction formats, Addressing modes, Instruction execution timing. **INSTRUCTION SET OF 8086:** Data transfer and arithmetic instructions. Illustration of these instructions with example programs.	**10 Hours**	**L1, L2, L3, L4**
Module -2		
BYTE AND STRING MANIPULATION: Branch type, loop, NOP & HALT, flag manipulation, logical and shift and rotate instructions String instructions, REP Prefix, Procedures, Directives and operators. Illustration of these instructions with example programs.	**10 Hours**	**L2, L3, L4**
Module -3		
8086 INTERRUPTS: Introduction to stack, stack structure of 8086, 8086 Interrupts and ISR, NMI, INTR, Interrupt programming, Passing parameters to procedures, Interrupt examples, Macros, Timing and Delays. **Basic Peripherals and their Interfacing with 8086 (Part 1)**: Semiconductor Memory Interfacing-Static RAM Interfacing of 8086, Interfacing I/O ports, 8255 PPI, Modes of operation.	**10 Hours**	**L1, L2, L3, L4, L5**
Module -4		

Basic Peripherals and their Interfacing with 8086 (Part 2): Interfacing ADC, Interfacing DAC, Stepper Motor Interfacing, Keyboard Interfacing, Seven Segment Display Interfacing. Signal Descriptions of 8086, Timing diagrams, Minimum and Maximum Mode of 8086.	**10 Hours**	**L2, L3, L4**
Module 5		
8086 BASED MULTIPROCESSING SYSTEMS: Coprocessor configurations, The 8087 numeric data processor: data types, processor architecture, instruction set and simple program examples. **Bus Interface and Higher bit Processors Introduction:** Features of Peripheral component interconnect (PCI) bus, the universal serial bus (USB). Introduction to 80286 to Pentium processors.	**10 Hours**	**L1, L2, L3**

Course outcomes:

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

- Write programs to run on 8086 microprocessor based systems.
- Design system using memory chips and peripheral chips for 16 bit 8086 microprocessor.
- Interface various peripherals to 8086.
- Write modular programs using procedures and macros.
- Write 8086 programs interleaved with 8087 instructions.
- Understand the features of high speed buses and higher bit processors.

Graduating Attributes (as per NBA)

- Engineering Knowledge
- Problem Analysis
- Design / development of solutions (partly)
- Investigations

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Advanced Microprocessors and Peripherals - A.K. Ray and K.M. Bhurchandi, TMH, 3rd Edition, 2012, ISBN 978-1-25-900613-5.

Reference Books:

1. **Microprocessor and Interfacing- Programming & Hardware**, Douglas V Hall, 2nd edition TMH, 2006.
2. **The 8086 Microprocessor: Programming & Interfacing The PC –** Kenneth J. Ayala, Cengage Learning, Indian Edition, 2011, ISBN-13:978-81-315-0180-1.
3. **Microcomputer systems-The 8086 / 8088 Family** – Y.C. Liu and A. Gibson, 2nd edition, PHI -2003.
4. **The Intel Microprocessor, Architecture, Programming and Interfacing** - Barry B. Brey, 6e, Pearson Education / PHI, 2003.

CONTROL SYSTEMS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV (EC/TC)

Subject Code	15EC43	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to:

- Know the basic features, configurations and application of control systems.
- Know various terminologies and definitions for the control systems.
- Learn how to find a mathematical model of electrical, mechanical and electro-mechanical systems.
- Know how to find time response from the transfer function.
- Find the transfer function via Masons' rule.
- Analyze the stability of a system from the transfer function.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1		
Introduction to Control Systems: Types of Control Systems, Effect of Feedback Systems, Differential equation of Physical Systems – Mechanical Systems, Electrical Systems, Analogous Systems. Block diagrams and signal flow graphs: Transfer functions, Block diagram algebra and Signal Flow graphs.	**10 Hours**	**L2, L3, L4**
Module -2		
Time Response of feedback control systems: Standard test signals, Unit step response of First and Second order Systems. Time response specifications, Time response specifications of second order systems, steady state errors and error constants. Introduction to PI, PD and PID Controllers (excluding design).	**10 Hours**	**L2, L3, L4**
Module -3		
Stability analysis: Concepts of stability, Necessary conditions for Stability, Routh stability criterion, Relative stability analysis: more on the Routh stability criterion, Introduction to Root-Locus Techniques, The root locus concepts, Construction of root loci.	**10 Hours**	**L1, L2, L3, L4**
Module -4		
Frequency domain analysis and stability: Correlation between time and frequency response, Bode Plots, Experimental determination of transfer function. Introduction to Polar Plots, (Inverse Polar Plots excluded) Mathematical preliminaries, Nyquist Stability criterion, (Systems with transportation lag excluded) Introduction to lead, lag and lead-lag compensating networks (excluding design).	**10 Hours**	**L2, L3, L4**

Module -5		
Introduction to Digital Control System: Introduction, Spectrum Analysis of Sampling process, Signal reconstruction, Difference equations. Introduction to State variable analysis: Introduction, Concept of State, State variables & State model, State model for Linear Continuous & Discrete time systems, Diaganolisation.	**10 Hours**	**L1, L2, L3**

Course outcomes:

- Know the benefits of using control systems.
- Design and analysis of various control systems.
- Find out the transfer function of electrical circuits, mechanical and electromechanical systems.
- Describe quantitatively the transient response of first and second order systems.
- Find the overall transfer function from the block diagram and signal flow graph.
- Understand and determine the stability using the Routh-Hurwitz technique.
- Use root-locus design to meet stability and to find the transient response.
- Find the digital responses from the transfer function.
- Draw the block diagram from the dynamic equation and represent the time.

Graduating Attributes (as per NBA)

- Engineering Knowledge
- Problem Analysis
- Design / development of solutions (partly)
- Investigations

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

J.Nagarath and M.Gopal, " Control Systems Engineering", New Age International (P) Limited, Publishers, Fifth edition-2005, ISBN: 81-224-2008-7.

Reference Books:

1. "Modern Control Engineering," K.Ogata, Pearson Education Asia/PHI, 4th Edition, 2002. ISBN 978-81-203-4010-7.
2. "Automatic Control Systems", Benjamin C. Kuo, John Wiley India Pvt. Ltd., 8th Edition, 2008.
3. "Feedback and Control System," Joseph J Distefano III et al., Schaum's Outlines, TMH, 2nd Edition 2007.

SIGNALS AND SYSTEMS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV (EC/TC)

Subject Code	15EC44	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to:

- Understand the mathematical description of continuous and discrete time signals and systems.
- Analyze the signals in time domain using convolution difference/differential equations
- Classify signals into different categories based on their properties.
- Analyze Linear Time Invariant (LTI) systems in time and transform domains.
- Build basics for understanding of courses such as signal processing, control system and communication.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1		
Introduction and Classification of signals: Definition of signal and systems, communication and control systems as examples. Sampling of analog signals, Continuous time and discrete time signal, Classification of signals as even, odd, periodic and non-periodic, deterministic and non-deterministic, energy and power. **Elementary signals/Functions:** exponential, sine, impulse, step and its properties, ramp, rectangular, triangular, signum, sync functions. **Operations on signals:** Amplitude scaling, addition, multiplication, differentiation, integration (Accumulator for DT), time scaling, time shifting and time folding. **Systems:** Definition, Classification: linear and non-linear, time variant and invariant, causal and non-causal, static and dynamic, stable and unstable, invertible.	**10 Hours**	**L2, L3, L4**
Module -2		
Time domain representation of LTI System: System modeling: Input-output relation, definition of impulse response, convolution sum, convolution integral, computation of convolution integral and convolution sum using graphical method for unit step to unit step, unit step to exponential, exponential to exponential, unit step to rectangular and rectangular to rectangular only. Properties of convolution.	**10 Hours**	**L2, L3, L4**

Module -3		
System interconnection, system properties in terms of impulse response, step response in terms of impulse response. **Fourier Representation of Periodic Signals**: Introduction to CTFS and DTFS, definition, properties (No derivation) and basic problems (inverse Fourier series is excluded).	**(04+06 Hours) 10 Hours**	**L1, L2, L3**
Module -4		
Fourier Representation of aperiodic Signals: **FT representation of aperiodic CT signals - FT,** definition, FT of standard CT signals, Properties and their significance. **FT representation of aperiodic discrete signals- DTFT**, definition, DTFT of standard discrete signals, Properties and their significance, **Impulse sampling and reconstruction:** Sampling theorem (only statement) and reconstruction of signals.	**(4+4+2 Hours) 10 Hours**	**L2, L3, L4**
Module -5		
Z-Transforms: Introduction, the Z-transform, properties of the Region of convergence, Properties of the Z-Transform, Inversion of the Z-Transform, Transform analysis of LTI systems.	**10 Hours**	**L1,L2, L3, L4**

Course outcomes:

- Understand mathematical description and representation of continuous and discrete time signals and systems.
- Develop input output relationship for linear shift invariant system and understand the convolution operator for continuous and discrete time system.
- Understand and resolve the signals in frequency domain using Fourier series and Fourier transforms.
- Understand the limitations of Fourier transform and need for Laplace transform and develop the ability to analyze the system in s- domain.
- Understand the basic concept of Z transform and to develop the ability to analyze systems in Z- domain.

Graduating Attributes (as per NBA)

- Engineering Knowledge
- Problem Analysis
- Design / development of solutions(partly)
- Investigations

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT Book:

Simon Haykins and Barry Van Veen, "Signals and Systems", 2nd Edition, 2008, Wiley India. ISBN 9971-51-239-4.

Reference Books:

1. **Michael Roberts,** "Fundamentals of Signals & Systems", 2nd edition, Tata McGraw-Hill, 2010, ISBN 978-0-07-070221-9.
2. **Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab,** "Signals and Systems" Pearson Education Asia / PHI, 2nd edition, 1997. Indian Reprint 2002.
3. **H. P Hsu, R. Ranjan,** "Signals and Systems", Scham's outlines, TMH, 2006.
4. **B. P. Lathi,** "Linear Systems and Signals", Oxford University Press, 2005.
5. **Ganesh Rao and Satish Tunga,** "Signals and Systems", Pearson/Sanguine Technical Publishers, 2004.

PRINCIPLES OF COMMUNICATION SYSTEMS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV (EC/TC)

Subject Code	15EC45	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to:

- Learn the concepts of random process and various types of noise.
- Design simple systems for generating and demodulating AM, DSB and SSB signals
- Understand the concepts in Angle modulation for the design of communication systems
- Design simple systems for generating and demodulating frequency modulated signals
- Evaluate the performance of the communication system in presence of noise.
- Analyze pulse modulation and sampling techniques

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1		
RANDOM PROCESS: Random variables: Several random variables. Statistical averages: Function of Random variables, moments, Mean, Correlation and Covariance function: Principles of autocorrelation function, cross – correlation functions. **NOISE:** Introduction, shot noise, thermal noise, white noise, Noise equivalent bandwidth, Narrow bandwidth, Noise Figure, Equivalent noise temperature, cascade connection of two-port networks.	**10 Hours**	**L2, L3, L4**

Module -2		
AMPLITUDE MODULATION: Introduction, AM: Time-Domain description, Frequency – Domain description. Generation of AM wave: square law modulator, switching modulator. Detection of AM waves: square law detector, envelop detector. **DOUBLE SIDE BAND SUPPRESSED CARRIER MODULATION (DSBSC):** Time and Frequency Domain description, Generation of DSBSC waves: balanced modulator, ring modulator. Coherent detection of DSBSC modulated waves. **SINGLE SIDE-BAND MODULATION(SSB):** Quadrature carrier multiplexing, Hilbert Transform and Properties, Single side-band modulation, Frequency and Time Domain description of SSB wave, Phase discrimination method for generating an SSB modulated wave. Demodulation of SSB waves, Radio broadcasting, AM radio.	**10 Hours**	**L2, L3, L4**
Module -3		
ANGLE MODULATION: Basic definitions, FM, narrow band FM, wide band FM, transmission bandwidth of FM waves, generation of FM waves: indirect FM and direct FM. Demodulation of FM waves, Phase-locked loop, Nonlinear model of the phase – locked loop, Linear model of the phase – locked loop.	**(04+06 Hours) 10 Hours**	**L1, L2, L3**
Module -4		
NOISE IN CONTINUOUS WAVE MODULATION SYSTEMS: Introduction, Receiver model, Noise in DSB-SC receivers, Noise in SSB receivers, Noise in AM receivers, Threshold effect. Noise in FM receivers, FM threshold effect, Pre-emphasis and De-emphasis in FM.	**(4+4+2 Hours) 10 Hours**	**L2, L3, L4**
Module -5		
PULSE MODULATION: Sampling process: Low pass impulse sampling and reconstruction; PAM: Pulse sampling, Flat top sampling; other forms of pulse modulation: PDM and PWM, Quantization process: PCM, Application to Vocoders.	**10 Hours**	**L1, L2, L3, L4, L5**

Course outcomes: At the end of this course, the students will be able to:

- Understand the concepts of random process and various types of noise.
- Design and develop simple systems for generating and demodulating AM, DSB and SSB signals
- Understand the concepts in Angle modulation for the design of communication systems
- Design and develop simple systems for generating and demodulating frequency modulated signals
- Evaluate the performance of the designed communication system in presence of noise and nonlinear models.
- Design and Analyze pulse modulation and sampling techniques

Graduating Attributes (as per NBA)

- Engineering Knowledge
- Problem Analysis
- Design / development of solutions

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT Books:

1. **Communication Systems**, Simon Haykins & Moher, 5th Edition, John Willey, India Pvt. Ltd, 2010 ISBN 978-81-265-3653-5
2. **An Introduction to Analog and Digital Communication**, Simon Haykins & Moher, John Wiley India Pvt. Ltd., 2012. ISBN 978-81-265-3653-5.

Reference Books:

1. **Principles of Communications,** Herbert Taub & D.L.Schilling, TMH, 3rd Edition, 2008.
2. **Modern digital and analog Communication systems,** B. P. Lathi, Oxford University Press., 4th ed, 2010.
3. **Communication Systems**, Harold P.E, Stern Samy and A Mahmond, Pearson Edn, 2004 ISBN 81-297-0686-5.
4. **Communication Systems** Analog and Digital, R.P.Singh and S.D.Sapre, TMH 2nd ed, 2007.

LINEAR INTEGRATED CIRCUITS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV (EC/TC)

Subject Code	15EC46	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to:

- Define the basic concepts of OP-Amp.
- Define and describe various parameters of Op-Amp, its characteristics and specifications.
- Discuss the effects of Input and Output voltage ranges upon Op-Amp circuits.
- Sketch and Analyze Op-Amp circuits to determine Input Impedances, output Impedances and other performance parameters.
- Sketch and Explain typical Frequency Response graphs for each of the Filter circuits showing Butterworth and Chebyshev responses where ever appropriate.
- Describe and Sketch the various switching circuits of Op-Amps and analyze its operations.
- Differentiate between various types of DACs and ADCs and evaluate the performance of each with neat circuit diagrams and assuming suitable inputs.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Operational Amplifier Fundamentals: Basic Op-amp circuit, Op-Amp parameters – Input and output voltage, CMRR and PSRR, offset voltages and currents, Input and output impedances, Slew rate and Frequency limitations. **OP-Amps as DC Amplifiers** – Biasing OP-amps, Direct coupled voltage followers, Non-inverting amplifiers, inverting amplifiers, Summing amplifiers, and Difference amplifiers. Interpretation of OP-amp LM741 & TL081 datasheet. **(Text1)**	**10 Hours**	**L1, L2, L3**
Module -2		
Op-Amps as AC Amplifiers: Capacitor coupled voltage follower, High input impedance – Capacitor coupled voltage follower, Capacitor coupled non inverting amplifiers, High input impedance – Capacitor coupled Non inverting amplifiers, Capacitor coupled inverting amplifiers, setting the upper cut-off frequency, Capacitor coupled difference amplifier. **OP-amp Applications:** Voltage sources, current sources and current sinks, current amplifiers, instrumentation amplifier, precision rectifiers. **(Text1)**	**10 Hours**	**L3, L4, L5**

Module-3		
More Applications : Limiting circuits, Clamping circuits, Peak detectors, Sample and hold circuits, V to I and I to V converters, Differentiating Circuit, Integrator Circuit, Phase shift oscillator, Wein bridge oscillator, Crossing detectors**,** inverting Schmitt trigger. **(Text 1)** Log and antilog amplifiers, Multiplier and divider. **(Text2)**	**10 Hours**	**L2, L3, L4**
Module -4		
Active Filters: First order and second order active Low-pass and high pass filters, Bandpass Filter, Bandstop Filter. **(Text 1)** **Voltage Regulators:** Introduction, Series Op-amp regulator, IC voltage regulators. 723 general purpose regulators. **(Text 2)**	**10 Hours**	**L2, L3, L4**
Module -5		
Phase locked loop: Basic Principles, Phase detector/comparator, VCO. **DAC and ADC convertor**: DAC using R-2R, ADC using Successive approximation. **Other IC Application:** 555 timer, Basic timer circuit, 555 timer used as astable and monostable multivibrator. **(Text 2)**	**10 Hours**	**L3, L4, L5**

Course outcomes:

After studying this course, students will be able to:

- Acquire knowledge and solve problems related to
  - Operational amplifiers and characteristics as well as various types of op-amps.
  - Functioning of PLL, VCO, V-I, I-V converters.
  - Active Filters, ADC, DAC.
  - 555 Timer
- Analyze the performance of
  - Op-amps and Various applications.
  - Instrumentation Amplifiers, Isolation Amplifiers, Wave Generators and Oscillators.
- Interpretation of Performance Characteristics of Practical Op-amps.
- Apply the knowledge gained in the design of practical circuits for amplifiers, filters oscillators, multivibrators, voltage regulators and electronic systems.

Graduate Attributes (as per NBA)

- Engineering Knowledge
- Problem Analysis
- Design / development of solutions

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under amodule.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. "Operational Amplifiers and Linear IC's", David A. Bell, 2nd edition, PHI/Pearson, 2004. ISBN 978-81-203-2359-9.
2. "Linear Integrated Circuits", D. Roy Choudhury and Shail B. Jain, 4nd edition, Reprint 2006, New Age International ISBN 978-81-224-3098-1.

Reference Books:

1. Ramakant A Gayakwad, "Op-Amps and Linear Integrated Circuits," Pearson, 4th Ed, 2015. ISBN 81-7808-501-1.
2. B Somanathan Nair, "Linear Integrated Circuits: Analysis, Design & Applications," Wiley India, 1st Edition, 2015.
3. James Cox, "Linear Electronics Circuits and Devices", Cengage Learning, Indian Edition, 2008, ISBN-13: 978-07-668-3018-7.
4. Data Sheet: http://www.ti.com/lit/ds/symlink/tl081.pdf.

MICROPROCESSOR LABORATORY

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV (EC/TC)

Laboratory Code	15ECL47	IA Marks	20
Number of Lecture Hours/Week	01Hr Tutorial (Instructions) + 02 Hours Laboratory	Exam Marks	80
		Exam Hours	03

CREDITS – 02

Course objectives: This course will enable students to:

- Get familiarize with 8086 instructions and DOS 21H interrupts and function calls.
- Develop and test assembly language programs to use instructions of 8086.
- Get familiarize with interfacing of various peripheral devices with 8086 microprocessor for simple applications.

Laboratory Experiments:	**Revised Bloom's Taxonomy (RBT) Level**
1. Programs involving: **Data transfer instructions like**: i) Byte and word data transfer indifferent addressing Modes ii) Block move (with and without overlap) iii) Block interchange	**L2, L3, L4**
2. Programs involving: **Arithmetic & logical operations like**: i) Addition and Subtraction of multi precision nos. ii) Multiplication and Division of signed and unsigned Hexadecimal nos. iii) ASCII adjustment instructions iv) Code conversions	**L1, L2, L3**
3. Programs involving: **Bit manipulation instructions like checking**: i) Whether given data is positive or negative ii) Whether given data is odd or even iii) Logical 1's and 0's in a given data iv) 2 out 5 code v) Bit wise and nibble wise palindrome	**L4, L5**
4. Programs involving: **Loop instructions like** i) Arrays: addition/subtraction of N nos., Finding largest and smallest nos., Ascending and descending order ii) Two application programs using Procedures and Macros (Subroutines)	**L4, L5**

5. Programs involving String manipulation like string transfer, string reversing, searching for a string	**L2, L3, L4**
6. Programs involving Programs to use DOS interrupt INT 21h Function calls for Reading a Character from keyboard, Buffered Keyboard input, Display of character/ String on console	**L2, L3, L4**
7. Interfacing Experiments: Experiments on interfacing 8086 with the following interfacing modules through DIO (Digital Input/Output - PCI bus compatible card / 8086 Trainer) 1. Matrix keyboard interfacing 2. Seven segment display interface 3. Logical controller interface 4. Stepper motor interface 5. Analog to Digital Converter Interface (8 bit) 6. Light dependent resistor (LDR), Relay and Buzzer Interface to make light operated switches	**L3, L4, L5**

Course outcomes: On the completion of this laboratory course, the students will be able to:

- Program a microprocessor to perform arithmetic, logical and data transfer applications.
- Understand assembler directives, DOS Interrupts, branch and loop operations.
- Interface a microprocessor to various devices for simple applications.
- Effectively utilize microprocessor peripherals.
- Utilize procedures and macros for modular programming.

Graduate Attributes (as per NBA)

- Engineering Knowledge.
- Problem Analysis.
- Design/Development of solutions.

Conduct of Practical Examination:

- All laboratory experiments are to be included for practical examination.
- For examination, one question from software and one question from hardware interfacing to be set.
- Students are allowed to pick one experiment from the lot.
- Change of experiment is allowed only once, in which case Procedure part Marks to be made zero.

LINEAR ICS AND COMMUNICATION LAB

As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV (EC/TC)

Laboratory Code	15ECL48	IA Marks	20
Number of Lecture Hours/Week	01Hr Tutorial (Instructions) + 02 Hours Laboratory	Exam Marks	80
		Exam Hours	03

CREDITS – 02

Course objectives: This laboratory course enables students to:

- Design, Demonstrate and Analyze instrumentation amplifier, filters, DAC, adder, differentiator and integrator circuits, using op-amp.
- Design, Demonstrate and Analyze multivibrators and oscillator circuits using Op-amp
- Design, Demonstrate and Analyze analog systems for AM, FM and Mixer operations.
- Design, Demonstrate and Analyze balance modulation and frequency synthesis.
- Demonstrate and Analyze pulse sampling and flat top sampling.

Laboratory Experiments:	**Revised Bloom's Taxonomy (RBT) Level**
1. Design an instrumentation amplifier of a differential mode gain of 'A' using three amplifiers.	**L2, L3, L4, L5**
2. Design of RC Phase shift and Wein's bridge oscillators using Op-amp.	**L2, L3, L4, L5**
3. Design active second order Butterworth low pass and high pass filters.	**L2, L3, L4, L5**
4. Design 4 bit R – 2R Op-Amp Digital to Analog Converter (i) using 4 bit binary input from toggle switches and (ii) by generating digital inputs using mod-16 counter.	**L2, L3, L4, L5**
5. Design Adder, Integrator and Differentiator using Op-Amp.	**L2, L3, L4, L5**
6. Design of Monostable and Astable Multivibrator using 555 Timer.	**L2, L3, L4, L5**
7. Demonstrate Pulse sampling, flat top sampling and reconstruction.	**L2, L3, L4**
8. Amplitude modulation using transistor/FET (Generation and detection).	**L2, L3, L4**
9. Frequency modulation using IC 8038/2206 and demodulation.	**L2, L3, L4**
10. Design BJT/FET Mixer.	**L2, L3, L4**
11.DSBSC generation using Balance Modulator IC 1496/1596.	**L2, L3, L4**
12. Frequency synthesis using PLL.	**L2, L3, L4, L5**

Course outcomes: This laboratory course enables students to:

- Gain hands-on experience in building analog systems for a given specification using the basic building blocks.
- Gain hands-on experience in AM and FM techniques, frequency synthesis
- Gain hands-on experience in pulse and flat top sampling techniques
- Make the right choice of an IC and design the circuit for a given application.
- Design and analyze the performance of instrumentation amplifier, LPF, HPF, DAC and oscillators using linear IC.
- Understand the applications of Linear IC for addition, integration and 555 timer operation to generate signals/pulses.

Graduate Attributes (as per NBA)

- Engineering Knowledge.
- Problem Analysis.
- Design/Development of solutions.

Conduct of Practical Examination:

- All laboratory experiments are to be included for practical examination.
- Students are allowed to pick one experiment from the lot.
- Change of experiment is allowed only once, in which case Procedure part Marks to be made zero.