# APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

(A State Government University)

# B .Tech

# Curriculum - 2024

www.ktu.edu.in

university@ktu.edu.in

| FOURTH SEMESTER (January - June) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sl. No:** | **Slot** | **Course Code** | **Course Type** | **Course Category** | **Course Title (Course Name)** | **Credit Structure** | | | | **SS** | **Total Marks** | | **Credits** | **Hrs./ Week** |
| | | | | | | **L** | **T** | **P** | **R** | | **CIA** | **ESE** | | |
| 1 | A | GBMAT401 | BSC | GC | Mathematics for Electrical Science-4 | 3 | 0 | 0 | 0 | 4.5 | 40 | 60 | 3 | 3 |
| 2 | B | PCECT402 | PC | PC | Signals and Systems | 3 | 1 | 0 | 0 | 5 | 40 | 60 | 4 | 4 |
| 3 | C | PCECT403 | PC | PC | Linear Integrated Circuits | 3 | 1 | 0 | 0 | 5 | 40 | 60 | 4 | 4 |
| 4 | D | PBECT404 | PC-PBL | PB | Microcontrollers | 3 | 0 | 0 | 1 | 5.5 | 60 | 40 | 4 | 4 |
| 5 | E | PEECT411 | PE | PE | Instrumentation | 3 | 0 | 0 | 0 | 4.5 | 40 | 60 | 3 | 3 |
| 6 | G | UCHUT346 | HMC* | UC | Economics for Engineers | 2 | 0 | 0 | 0 | 3 | 50 | 50 | 2 | 2 |
| 7 | L | PCECL407 | PCL | PC | Linear Integrated Circuits Lab | 0 | 0 | 3 | 0 | 1.5 | 50 | 50 | 2 | 3 |
| 8 | Q | PCECL408 | PCL | PC | Microcontroller Lab | 0 | 0 | 3 | 0 | 1.5 | 50 | 50 | 2 | 3 |
| 9 | H | HNECT409 | VAC | | Linear Algebra for Communication | 3 | 1 | 0 | 0 | 5 | | | 4* | 4* |
| **Total** | | | | | | | | | | **31/ 36** | | | **24/28** | **26/30*** |

# SEMESTER 4

## ELECTRONICS & COMMUNICATION ENGINEERING

## SEMESTER S4

## MATHEMATICS FOR ELECTRICAL SCIENCE – 4

| Course Code | GBMAT401 | CIE Marks | 40 |
|---|---|---|---|
| Teaching Hours/Week (L: T:P: R) | 3:0:0:0 | ESE Marks | 60 |
| Credits | 3 | Exam Hours | 2 Hrs. 30 Min. |
| Prerequisites (if any) | Basic calculus | Course Type | Theory |

**Course Objectives:**

1. To familiarize students with the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science.
2. To expose the students to the basics of random processes essential for their subsequent study of analog and digital communication

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | Random variables, Discrete random variables and their probability distributions, Cumulative distribution function, Expectation, Mean and variance, Binomial distribution, Poisson distribution, Poisson distribution as a limit of the binomial distribution, Joint pmf of two discrete random variables, Marginal pmf, Independent random variables, Expected value of a function of two discrete variables. **[Text 1: Relevant topics from sections 3.1 to 3.4, 3.6, 5.1, 5.2]** | 9 |
| 2 | Continuous random variables and their probability distributions, Cumulative distribution function, Expectation, Mean and variance, Uniform, Normal and Exponential distributions, Joint pdf of two Continuous random variables, Marginal pdf, Independent random variables, Expectation value of a function of two continuous variables. **[Text 1: Relevant topics from sections 3.1, 4.1, 4.2, 4.3, 4.4, 5.1, 5.2]** | 9 |
| 3 | Confidence Intervals, Confidence Level, Confidence Intervals and One-side confidence intervals for a Population Mean for large and | 9 |

| | | |
|---|---|---|
| | small samples (normal distribution and *t*-distribution), Hypotheses and Test Procedures, Type I and Type II error, *z* Tests for Hypotheses about a Population Mean (for large sample), *t* Test for Hypotheses about a Population Mean (for small sample), Tests concerning a population proportion for large and small samples.<br>**[Text 1: Relevant topics from 7.1, 7.2, 7.3, 8.1, 8.2, 8.3, 8.4]** | |
| **4** | Random process concept, classification of process, Methods of Description of Random process, Special classes, Average Values of Random Process, Stationarity- SSS, WSS, Autocorrelation functions and its properties, Ergodicity, Mean-Ergodic Process, Mean-Ergodic Theorem, Correlation Ergodic Process, Distribution Ergodic Process.<br>**[Text 2: Relevant topics from Chapter 6]** | **9** |

## Course Assessment Method
## (CIE: 40 marks, ESE: 60 marks)

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment/ Micro project | Internal Examination-1 (Written) | Internal Examination- 2 (Written) | Total |
|---|---|---|---|---|
| **5** | **15** | **10** | **10** | **40** |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 sub divisions.<br>**(4x9 = 36 marks)** | **60** |

## Course Outcomes (COs)

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

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Illustrate the concept, properties and important models of discrete random variables and to apply in suitable random phenomena. | **K3** |
| **CO2** | Describe the concept, properties and important models of continuous random variables and to apply in suitable random phenomena. | **K3** |
| **CO3** | Estimate population parameters, assess their certainty with confidence intervals, and test hypotheses about population means and proportions using *z*-tests and the one-sample *t*-test. | **K3** |
| **CO4** | Analyze random processes by classifying them, describing their properties, utilizing autocorrelation functions, and understanding their applications in areas like signal processing and communication systems. | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | 2 |
| **CO2** | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | 2 |
| **CO3** | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | 2 |
| **CO4** | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | 2 |

| Text Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Probability and Statistics for Engineering and the Sciences | Devore J. L | Cengage Learning | 9th edition, 2016 |
| **2** | Probability, Statistics and Random Processes | T Veerarajan | The McGraw-Hill | 3rd edition, 2008 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Probability, Random Variables and Stochastic Processes, | Papoulis, A. & Pillai, S.U., | McGraw Hill. | 4th edition, 2002 |
| **2** | Introduction to Probability and Statistics for Engineers and Scientists | Ross, S. M. | Academic Press | 6th edition, 2020 |
| **3** | Probability and Random Processes | Palaniammal, S. | PHI Learning Private Limited | 3rd edition, 2015 |
| **4** | Introduction to Probability | David F. Anderson, Timo, Benedek | Cambridge | 1st edition, 2017 |

| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **Module No.** | **Link ID** |
| **1** | https://archive.nptel.ac.in/courses/117/105/117105085/ |
| **2** | https://archive.nptel.ac.in/courses/117/105/117105085/ |
| **3** | https://archive.nptel.ac.in/courses/117/105/117105085/ |
| **4** | https://archive.nptel.ac.in/courses/117/105/117105085/ |

## SEMESTER S4

# SIGNALS AND SYSTEMS

| | | | |
|---|---|---|---|
| **Course Code** | **PCECT402** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T:P: R)** | 3:1:0:0 | **ESE Marks** | 60 |
| **Credits** | 4 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | Mathematics for Electrical and Physical Sciences (GYMAT101, GYMAT201) | **Course Type** | Theory |

**Course Objectives:**

1. To provide sufficient understanding of different types of signals and systems in time and frequency domain.
2. Analyze LTI systems in time and frequency domain using different transforms

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | **Introduction to signals and systems:**<br>Continuous time and discrete time signals - Elementary signals, Classification of signals, Basic signal operations.<br>Continuous time and discrete time systems – Representation and Classification (memory, causal, stable, linear, time-invariant, invertible)<br>Convolution integral and convolution sum operations.<br>Continuous time and discrete time LTI systems-Stability and causality of LTI systems. | 11 |
| 2 | **Frequency domain representation of continuous time signals:**<br>Continuous time Fourier series - Exponential Fourier series representation of periodic signals.<br>Continuous time Fourier transform - Convergence and Gibbs phenomenon, Continuous time Fourier transform of standard signals, Properties of Continuous time Fourier transform, Inverse Transform.<br>Bilateral Laplace Transform, Concept of ROC, Relation of Laplace transform to Fourier Transform. | 11 |

| | | |
|---|---|---|
| **3** | **Sampling of continuous time signals to discrete signals and frequency domain representation of discrete time signals:**<br>Conversion of continuous time signal to discrete time signal, Sampling theorem for low pass signals, Nyquist criteria, Aliasing.<br><br>Discrete time Fourier series for discrete periodic signals.<br>Discrete time Fourier transform (DTFT)-Convergence condition, DTFT of standard signals, Properties of DTFT, Inverse transform.<br>Z transform- ROC, Properties (Proof not needed), Inverse transform, Relation between DTFT and Z-Transform. | **11** |
| **4** | **Analysis of LTI systems using Transforms**<br>Concept of transfer function-Frequency response, Magnitude response and phase response.<br>Analysis of Continuous time LTI systems using Laplace and Fourier transforms.<br>Analysis of discrete time LTI systems using DTFT and Z transforms, Stability and causality using Z transform. | **11** |

**Course Assessment Method**
**(CIE: 40 marks, ESE: 60 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment/ Micro project | Internal Examination-1 (Written) | Internal Examination- 2 (Written) | Total |
|---|---|---|---|---|
| **5** | **15** | **10** | **10** | **40** |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br><br>**(8x3 =24marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 sub divisions.<br>**(4x9 = 36 marks)** | **60** |

## Course Outcomes (COs)

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

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Classify continuous and discrete time signals and systems based on their properties and perform basic operations on signals. | **K2** |
| **CO2** | Determine the stability and causality of LTI systems using convolution operations. | **K3** |
| **CO3** | Analyze signals in frequency domain using various transforms and examine their properties. | **K3** |
| **CO4** | Interpret the use of various transforms to analyze continuous and discrete time LTI systems. | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

## CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | | | 2 | | | | | | | 1 |
| **CO2** | 3 | 3 | 2 | 2 | 2 | | | | | | | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | | | | | | | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 2 | | | | | | | 3 |

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

| Text Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Signals and Systems | Alan V. Oppenheim and Alan Willsky | Pearson | 2/e, 2015 |
| 2 | Signals and Systems | Simon Haykin | John Wiley | 2/e, 2021 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Signals and Systems | Anand Kumar | PHI | 3/e, 2013 |
| 2 | Principles of Signal Processing & Linear systems | B P. Lathi | Oxford University Press | 2/e, 2009 |
| 3 | Signals & Systems - Continuous and Discrete | Rodger E. Ziemer | Pearson | 4/e, 2013 |
| 4 | Analog and Digital Signal Processing | Ashok Ambardar | Brooks/Cole Publishing Company | 2/e, 2013 |
| 5 | Signals and systems - Principles and Applications | Shaila Dinkar Apte | Cambridge University Press | 1/e, 2016 |

| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **Module No.** | **Link ID** |
| **1** | https://nptel.ac.in/courses/117101055<br>https://nptel.ac.in/courses/117104074<br>https://nptel.ac.in/courses/108104100 |
| **2** | Same as above |
| **3** | Same as above |
| **4** | Same as above |

## SEMESTER S4

# LINEAR INTEGRATED CIRCUITS

| | | | |
|---|---|---|---|
| **Course Code** | **PCECT403** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T:P: R)** | 3:1:0:0 | **ESE Marks** | 60 |
| **Credits** | 4 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | Analog Circuits (PCECT303) | **Course Type** | Theory |

**Course Objectives:**

1. To develop skills to design and analyze circuits using operational amplifiers for various applications.

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | **Differential Amplifiers:** Differential amplifier configurations using BJT, DC Analysis - transfer characteristics; AC analysis - differential and common mode gains, CMRR, input and output resistance, voltage gain, constant current bias, constant current source.<br>**Concept of current mirror**: two-transistor current mirror, Wilson and Widlar current mirrors.<br>**Operational amplifiers (Op Amps):** The 741 Op Amp, Block diagram, Ideal Op Amp parameters, typical parameter values for 741, equivalent circuit, open loop configurations, voltage transfer curve, frequency response curve. | **11** |
| 2 | **Op Amp with negative feedback:** General concept of Voltage Series, Voltage Shunt, Current Series and Current Shunt negative feedback, Op Amp circuits with Voltage Series and Voltage Shunt feedback, Virtual ground concept.<br>Analysis of inverting and non-inverting amplifier for closed loop gain, Input Resistance and Output Resistance.<br>**Op Amp applications:** Summer, Voltage Follower, Differential and Instrumentation Amplifiers, Voltage to Current and Current to Voltage converters, Integrator, Differentiator, Precision Rectifiers, Comparators, Schmitt Triggers, Log and Antilog amplifiers. | **11** |

| | | |
|---|---|---|
| **3** | **Oscillators and Multivibrators:** Phase Shift and Wien-bridge Oscillators, Triangular and Sawtooth waveform generators, Astable and Monostable multivibrators.<br>**Active filters:** Comparison with passive filters, First and Second order Low pass, High pass, Band pass and Band Reject active filters, State Variable filters.<br>**Voltage Regulators:** Fixed and Adjustable voltage regulators, IC 723 – Low voltage and High voltage configurations, Current boosting, Current limiting, Short circuit and Fold-back protection. | **11** |
| **4** | **Timer and VCO:** Timer IC 555 - Functional diagram, Astable and monostable operations, Basic concepts of Voltage Controlled Oscillator and application of VCO IC LM566.<br>**Phase Locked Loop**: Basic building block, Operation, Closed loop analysis, Lock and capture range, Applications of PLL, PLL IC565.<br>**Data Converters:** Digital to Analog converters, Specifications, Weighted resistor type and R-2R Ladder type.<br>Analog to Digital Converters: Specifications, Flash type and Successive approximation type. | **11** |

## Course Assessment Method
## (CIE: 40 marks, ESE: 60 marks)

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment/ Micro project | Internal Examination-1 (Written) | Internal Examination- 2 (Written) | Total |
|---|---|---|---|---|
| **5** | **15** | **10** | **10** | **40** |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br><br>**(8x3 =24marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 sub divisions.<br>**(4x9 = 36 marks)** | **60** |

## Course Outcomes (COs)

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

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Summarize the concepts of operational amplifiers and differential amplifier configurations | **K2** |
| **CO2** | Design operational amplifier circuits for various applications. | **K3** |
| **CO3** | Choose integrated circuit chips for various linear circuit applications. | **K2** |
| **CO4** | Implement various applications using specific integrated circuit chips | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

## CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | | | | | | | 1 |
| **CO2** | 3 | 2 | 3 | 3 | 2 | | | | | | | 2 |
| **CO3** | 3 | | | | 2 | | | | | | | 2 |
| **CO4** | 3 | 2 | 2 | 2 | 2 | | | | | | | 2 |

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

| Text Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Linear Integrated Circuits | Roy D. C. and S. B. Jain | New Age International | 5/e, 2018 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Design with Operational Amplifiers and Analog Integrated Circuits | Sergio Franco | Tata McGraw Hill | 3/e, 2017 |
| 2 | Op-Amps and Linear Integrated Circuits | Gayakwad R. A. | Prentice Hall | 4/e, 2015 |
| 3 | Integrated Circuits | Botkar K. R. | Khanna Publishers | 10/e, 2013 |
| 4 | Operational Amplifiers | C.G. Clayton | Butterworth & Company Publ. Ltd. Elsevier | 5/e, 2005 |
| 5 | Operational Amplifiers & Linear Integrated Circuits | R.F. Coughlin & Fredrick Driscoll | PHI | 6/e, 2000 |
| 6 | Operational Amplifiers & Linear ICs | David A. Bell | Oxford University Press | 3/e, 2011 |
| 7 | Microelectronic Circuits | Sedra A. S. and K. C. Smith | Oxford University Press | 6/e, 2013 |

| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **Module No.** | **Link ID** |
| **1** | https://nptel.ac.in/courses/117101106 |
| **2** | https://nptel.ac.in/courses/117101106 |
| **3** | https://nptel.ac.in/courses/117101106 |
| **4** | https://nptel.ac.in/courses/117101106 |

## SEMESTER S4

# MICROCONTROLLERS

| Course Code | PBECT404 | CIE Marks | 60 |
|---|---|---|---|
| Teaching Hours/Week (L: T:P: R) | 3:0:0:1 | ESE Marks | 40 |
| Credits | 4 | Exam Hours | 2 Hrs. 30 Min. |
| Prerequisites (if any) | PBECT304-Logic Circuit Design | Course Type | Theory |

**Course Objectives:**

1. To learn Microcontroller architecture and its programming
2. To learn embedded system design to develop a product.

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | Microcontroller Architecture – General internal architecture, Address bus, Data bus, control bus.<br>The Microcontroller 8051: Features of 8051 microcontroller, Block diagram of 8051- program status word (PSW), accumulator, program counter. Memory organization – RAM & ROM, register banks and stack, Special Function Registers (SFRs), I/O port organization, Interrupts. | 9 |
| 2 | Instruction Set of 8051 & Addressing modes: Classification of instruction set - Data transfer group, arithmetic group, logical group, branching group.<br>Addressing modes - Types. Accessing the data from internal and external memory. | 9 |
| 3 | Programming 8051 Using Assembly Language: Introduction to 8051 assembly language programming. Data types & directives, Concept of subroutine. Software delay programming.<br>Programming 8051 Using Embedded C Language: Introduction to embedded C – advantages. | 9 |
| 4 | Timer / Counter in 8051: Timer registers - Timer0, Timer1. Configuration of timer registers. Timer mode programming. Counter mode. | 9 |

| | | |
|---|---|---|
| | Serial Communication in 8051: Serial communication – modes and protocols, RS-232 pin configuration and connection. Serial port programming – transmitting and receiving.<br>Programming the interrupts: Use external, timer and serial port interrupts. Interrupt priority settings. | |

**Suggestion on Project Topics**

1. Interface any known ADC chip to 8051 uC. Read the variation in voltage from a potentiometer and display it on an LCD module.
2. Interface any known DAC chip to 8051 uC. Generate a Sine waveform of 1KHz at any port pin.
3. DC motor interface for speed and direction control.
4. Stepper motor interface - Unit step control, Rotation angle control, Speed control, Direction control
5. Read the Temperature sensor and display it on LCD.

**Course Assessment Method**
**(CIE: 60 marks, ESE: 40 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Project | Internal Ex-1 | Internal Ex-2 | Total |
|---|---|---|---|---|
| 5 | 30 | 12.5 | 12.5 | 60 |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 2 marks<br>**(8x2 =16 marks)** | • 2 questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 2 sub divisions.<br>• Each question carries 6 marks.<br>**(4x6 = 24 marks)** | **40** |

## Course Outcomes (COs)

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

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Outline Architecture of Microcontroller | **K2** |
| **CO2** | Develop Microcontroller programs | **K5** |
| **CO3** | Design various interfaces to Microcontroller | **K5** |
| **CO4** | Design and implement an Embedded System | **K6** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | | | | | | | | | | |
| **CO2** | 3 | 3 | 3 | 2 | 3 | | | 2 | | | | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | | | 2 | | | | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

| **Text Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | The 8051 Microcontroller and Embedded Systems Using Assembly and C | Muhammad Ali Mazidi Janice Gillispie Mazidi Rolin D. McKinlay | Prentice Hall -Inc | Second, 2007 |
| **2** | The 8051 Microcontroller Architecture, Programming and Applications | Kenneth J Ayala Dhananjay V Gadre | Cengage Learning | 2010 |

| **Reference Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | 8051 hardware Description | Datasheet | Intel Corporation | 1992 |
| **2** | Microprocessors and Microcontrollers | Lyla B. Das | Pearson Education | 2011 |

| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **Module No.** | **Link ID** |
| **1** | Microprocessors and Microcontrollers - https://nptel.ac.in/courses/106108100 |
| **2** | Microcontrollers and Applications - https://nptel.ac.in/courses/117104072 |

## PBL Course Elements

| **L: Lecture (3 Hrs.)** | **R: Project (1 Hr.), 2 Faculty Members** | | |
|---|---|---|---|
| | **Tutorial** | **Practical** | **Presentation** |
| Lecture delivery | Project identification | Simulation/ Laboratory Work/ Workshops | Presentation (Progress and Final Presentations) |
| Group discussion | Project Analysis | Data Collection | Evaluation |
| Question answer Sessions/ Brainstorming Sessions | Analytical thinking and self-learning | Testing | Project Milestone Reviews, Feedback, Project reformation (If required) |
| Guest Speakers (Industry Experts) | Case Study/ Field Survey Report | Prototyping | Poster Presentation/ Video Presentation: Students present their results in a 2 to 5 minutes video |

## Assessment and Evaluation for Project Activity

| **Sl. No** | **Evaluation for** | **Allotted Marks** |
|---|---|---|
| 1 | Project Planning and Proposal | 5 |
| 2 | Contribution in Progress Presentations and Question Answer Sessions | 4 |
| 3 | Involvement in the project work and Team Work | 3 |
| 4 | Execution and Implementation | 10 |
| 5 | Final Presentations | 5 |
| 6 | Project Quality, Innovation and Creativity | 3 |
| **Total** | | **30** |

1. **Project Planning and Proposal (5 Marks)**
    - Clarity and feasibility of the project plan
    - Research and background understanding
    - Defined objectives and methodology
2. **Contribution in Progress Presentation and Question Answer Sessions (4 Marks)**
    - Individual contribution to the presentation
    - Effectiveness in answering questions and handling feedback
3. **Involvement in the Project Work and Team Work (3 Marks)**
    - Active participation and individual contribution
    - Teamwork and collaboration
4. **Execution and Implementation (10 Marks)**
    - Adherence to the project timeline and milestones
    - Application of theoretical knowledge and problem-solving
    - Final Result
5. **Final Presentation (5 Marks)**
    - Quality and clarity of the overall presentation
    - Individual contribution to the presentation
    - Effectiveness in answering questions
6. **Project Quality, Innovation, and Creativity (3 Marks)**
    - Overall quality and technical excellence of the project
    - Innovation and originality in the project
    - Creativity in solutions and approaches

## SEMESTER S4

## INSTRUMENTATION

| | | | |
|---|---|---|---|
| **Course Code** | **PEECT 411** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T:P: R)** | 3:0:0:0 | **ESE Marks** | 60 |
| **Credits** | 3 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | None/ (Course code) | **Course Type** | Theory |

**Course Objectives:**

1. This course aims to introduce the basic concepts of electronic measuring instruments.

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | **Introduction to measuring instruments**<br>Generalized Configurations and Functional elements of Instrumentation systems, Need for Measurement Systems, Classification of Types of Measuring instruments. Static and Dynamic characteristics of measuring instruments. | 9 |
| 2 | **Sensors and Transducers**<br>Classification and selection criteria of Transducers<br>Principles of operation, construction, theory, advantages and disadvantages, applications of<br>**Resistive Transducers:** Potentiometers, strain gauges, (metallic and semi-conductor type), Resistance Thermometer, Thermistors.<br>**Inductive Transducers:** LVDT (Linear variable differential transformer).<br>**Capacitive Transducers:** various capacitive transducers based upon familiar equation of capacitance (capacitive microphone) | 9 |
| 3 | **Electronic Measuring Instruments**<br>Digital storage oscilloscope, Working principle and applications of waveform analyser, digital frequency meter, harmonic distortion meter, harmonic analyser, spectrum analyser and logic state analyser IEEE - | 9 |

| | | |
|---|---|---|
| | 488 General Purpose Interface Bus (GPIB) Instruments with application.<br>EMI,<br>Grounding and Shielding | |
| **4** | **PLC Programming**<br>Basic PLC Programming: Programming ON/OFF Inputs, Creating Ladder diagrams, Register Basics, PLC Timers and Counters, PLC Arithmetic functions, Number comparison functions, Data handling Functions: Skip function and applications; master control relay function and applications; jump with non-return and return; data table, register and other move functions, PLC functions with BITS. | **9** |

**Course Assessment Method**
**(CIE: 40 marks, ESE: 60 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment/ Micro project | Internal Examination-1 (Written) | Internal Examination- 2 (Written) | Total |
|---|---|---|---|---|
| **5** | **15** | **10** | **10** | **40** |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 sub divisions.<br>**(4x9 = 36 marks)** | **60** |

## Course Outcomes (COs)

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

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Interpret the basic concepts of measuring instruments, its classification, and selection criteria. | **K2** |
| **CO2** | Outline the principle, construction and working of transducers for measuring physical variables. | **K2** |
| **CO3** | Comprehend the principle, construction and working of various electronic measuring instruments. | **K2** |
| **CO4** | Apply PLC programming for selected industrial processes. | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

## CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | | | | | | | | | | |
| **CO2** | 3 | 3 | 3 | | | | | | | | | |
| **CO3** | 3 | 3 | 3 | | | | | | | | | |
| **CO4** | 3 | 3 | 3 | | | | | | | | | |

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

| **Text Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Doebelin's Measurement Systems | Ernest Doebelin, Dhanesh N. Manik | Tata McGraw Hill | 6/e, 2011 |
| 2 | Electronic Instrumentation | Kalsi H S | Tata McGraw Hill | 4/e, 2019 |
| 3 | Programmable Logic controllers Programming Methods and Applications | John R Hackworth, Frederick D Hackworth | Pearson Education | 3/e, 2022 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | "Electrical and Electronics Measurements and Instrumentation," | Sawhney AK, | Dhanpat Rai and Sons | 2023 |
| 2 | "Programmable Logic Controllers- Principles and applications | John W Webb, Ronald A. Reis, | Pearson | 5/e, 2015 |

| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **Module No.** | **Link ID** |
| **1** | https://archive.nptel.ac.in/courses/108/105/108105064/ |
| **2** | https://archive.nptel.ac.in/courses/108/105/108105153/ |

## SEMESTER S4

# ECONOMICS FOR ENGINEERS

## (Common to All Branches)

| | | | |
|---|---|---|---|
| **Course Code** | **UCHUT346** | **CIE Marks** | 50 |
| **Teaching Hours/Week (L: T:P: R)** | 2:0:0:0 | **ESE Marks** | 50 |
| **Credits** | 2 | **Exam Hours** | 2.30 |
| **Prerequisites (if any)** | None | **Course Type** | Theory |

**Course Objectives:**

1. Understanding of finance and costing for engineering operation, budgetary planning and control
2. Provide fundamental concept of micro and macroeconomics related to engineering industry
3. Deliver the basic concepts of Value Engineering.

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | Basic Economics Concepts - Basic economic problems – Production Possibility Curve – Utility – Law of diminishing marginal utility – Law of Demand - Law of supply – Elasticity - measurement of elasticity and its applications – Equilibrium- Changes in demand and supply and its effects<br>Production function - Law of variable proportion – Economies of Scale – Internal and External Economies – Cobb-Douglas Production Function | 6 |
| 2 | Cost concepts – Social cost, private cost – Explicit and implicit cost – Sunk cost - Opportunity cost - short run cost curves - Revenue concepts<br>Firms and their objectives – Types of firms – Markets - Perfect Competition – Monopoly - Monopolistic Competition - Oligopoly (features and equilibrium of a firm) | 6 |

| | | |
|---|---|---|
| **3** | Monetary System – Money – Functions - Central Banking –Inflation - Causes and Effects – Measures to Control Inflation - Monetary and Fiscal policies – Deflation<br>Taxation – Direct and Indirect taxes (merits and demerits) - GST<br>National income – Concepts - Circular Flow – Methods of Estimation and Difficulties - Stock Market – Functions- Problems faced by the Indian stock market-Demat Account and Trading Account – Stock market Indicators- SENSEX and NIFTY | **6** |
| **4** | Value Analysis and value Engineering - Cost Value, Exchange Value, Use Value, Esteem Value - Aims, Advantages and Application areas of Value Engineering - Value Engineering Procedure - Break-even Analysis - Cost-Benefit Analysis - Capital Budgeting - Process planning | **6** |

**Course Assessment Method**
**(CIE: 50 marks, ESE: 50 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment/ Case study/ Micro project | Internal Examination-1 (Written) | Internal Examination- 2 (Written) | Total |
|---|---|---|---|---|
| **10** | **15** | **12.5** | **12.5** | **50** |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • Minimum 1 and Maximum 2 Questions from each module.<br>• Total of 6 Questions, each carrying 3 marks<br>**(6x3 =18marks)** | • 2 questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 2 sub divisions.<br>• Each question carries 8 marks.<br>**(4x8 = 32 marks)** | **50** |

## Course Outcomes (COs)

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

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Describe the fundamentals of various economic issues using laws and learn the concepts of demand, supply, elasticity and production function. | **K2** |
| **CO2** | Develop decision making capability by applying concepts relating to costs and revenue, and acquire knowledge regarding the functioning of firms in different market situations. | **K3** |
| **CO3** | Outline the macroeconomic principles of monetary and fiscal systems, national income and stock market. | **K2** |
| **CO4** | Make use of the possibilities of value analysis and engineering, and solve simple business problems using break even analysis, cost benefit analysis and capital budgeting techniques. | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | - | - | - | 1 | - | - | - | - | 1 | - |
| **CO2** | - | - | - | - | - | 1 | 1 | - | - | - | 1 | - |
| **CO3** | - | - | - | - | 1 | - | - | - | - | - | 2 | - |
| **CO4** | - | - | - | - | 1 | 1 | - | - | - | - | 2 | - |

| Text Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Managerial Economics | Geetika, Piyali Ghosh and Chodhury | Tata McGraw Hill, | 2015 |
| **2** | Engineering Economy | H. G. Thuesen, W. J. Fabrycky | PHI | 1966 |
| **3** | Engineering Economics | R. Paneerselvam | PHI | 2012 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Engineering Economy | Leland Blank P.E, Anthony Tarquin P. E. | Mc Graw Hill | 7TH Edition |
| **2** | Indian Financial System | Khan M. Y. | Tata McGraw Hill | 2011 |
| **3** | Engineering Economics and analysis | Donald G. Newman, Jerome P. Lavelle | Engg. Press, Texas | 2002 |
| **4** | Contemporary Engineering Economics | Chan S. Park | Prentice Hall of India Ltd | 2001 |

## SEMESTER S4

# LINEAR INTEGRATED CIRCUITS LAB

| | | | |
|---|---|---|---|
| **Course Code** | **PCECL407** | **CIE Marks** | 50 |
| **Teaching Hours/Week (L: T:P: R)** | 0:0:3:0 | **ESE Marks** | 50 |
| **Credits** | 2 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | PCECT303 | **Course Type** | Lab |

**Course Objectives:**

1. To study the design and implementation of various Linear Integrated Circuits.
2. To familiarize the simulation of basic Linear Integrated Circuits.

**Details of Experiment**

| **Expt. No.** | **Part A – List of Experiments using Op Amps (Minimum seven experiments mandatory)** |
|---|---|
| 1 | Familiarization of Operational amplifiers - Inverting and Non inverting amplifiers, Integrator, Differentiator - frequency response, Adder, Comparators |
| 2 | Measurement of Op-Amp parameters |
| 3 | Difference Amplifier and Instrumentation amplifier |
| 4 | Schmitt trigger circuit |
| 5 | Astable and Monostable multivibrators |
| 6 | Waveform generators using Op Amps - Triangular and Sawtooth |
| 7 | Wien bridge oscillator - without & with amplitude stabilization |
| 8 | RC Phase shift Oscillator |
| 9 | Active first and second order filters (LPF, HPF, BPF and BRF) |
| 10 | Active Notch filter to eliminate the 50Hz power line frequency |
| 11 | Precision rectifiers |
| **Expt. No** | **Part B – Application circuits using ICs [Minimum three experiments are to be done]** |
| 1 | Astable and Monostable multivibrator using Timer IC NE555 |
| 2 | DC power supply using IC 723: Low voltage and high voltage configurations, Short circuit and Fold-back protection. |
| 3 | A/D converters- counter ramp and flash type. |
| 4 | D/A Converters - R-2R ladder circuit |
| 5 | Study of PLL IC: free running, frequency lock range and capture range |

| Expt No. | **Part C – Simulation experiments**<br>**[**The experiments shall be conducted using open tools such as QUCS, KiCad or variants of SPICE]<br>**]** |
|---|---|
| **1** | Simulation of any three circuits from experiments 3, 5, 6, 7, 8, 9, 10 and 11 of section I |
| **2** | Simulation of experiments 3 or 4 from section II |

## Course Assessment Method
## (CIE: 50 marks, ESE: 50 marks)

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment) | Internal Examination | Total |
|---|---|---|---|
| **5** | **25** | **20** | **50** |

**End Semester Examination Marks (ESE):**

| Procedure/ Preparatory work/Design/ Algorithm | Conduct of experiment/ Execution of work/ troubleshooting/ Programming | Result with valid inference/ Quality of Output | Viva voce | Record | Total |
|---|---|---|---|---|---|
| **10** | **15** | **10** | **10** | **5** | **50** |

- ***Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.***
- ***Endorsement by External Examiner:*** *The external examiner shall endorse the record*

## Course Outcomes (COs)

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

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Design and implement basic linear integrated circuits using Op Amps. | **K4** |
| **CO2** | Design and implement basic linear integrated circuits using linear ICs. | **K4** |
| **CO3** | Design and simulate the functioning of basic linear integrated circuits and linear ICs. using simulation tools. | **K4** |
| **CO4** | Effectively troubleshoot a given circuit and analyze it | **K4** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

### CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | | | | | | 3 | | | 3 |
| **CO2** | 3 | 3 | 2 | | | | | | 3 | | | 3 |
| **CO3** | 3 | 3 | 2 | | 3 | | | | 3 | | | 3 |
| **CO4** | 3 | 3 | 2 | | | | | | 3 | | | 3 |

*1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

| Text Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Linear Integrated Circuits | D. Roy Choudhary and Shail B Jain | New Age International Private Limited | 6th edition, 2021 |
| 2 | Introduction to Pspice Using Orcad for Circuits and Electronics | M. H. Rashid | Pearson | 3rd edition, 2015 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Op-Amps And Linear Integrated Circuits: Business Management | Gayakwad | PHI | 2002 |
| **2** | Linear Integrated Circuits | D Roy Choudhury, Shail Bala Jain | New Age International | (2018) |

| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **Module No.** | **Link ID** |
| **1** | https://onlinecourses.nptel.ac.in/noc24_ee73/preview |
| **2** | https://archive.nptel.ac.in/courses/108/108/108108111/ |

## Continuous Assessment (25 Marks)

### 1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

### 2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

### 3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. **Viva Voce (5 Marks)**

    - Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

***Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.***

## Evaluation Pattern for End Semester Examination (50 Marks)

1. **Procedure/Preliminary Work/Design/Algorithm (10 Marks)**

    - Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
    - Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
    - Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
    - Creativity and logic in algorithm or experimental design.

2. **Conduct of Experiment/Execution of Work/Programming (15 Marks)**

    - Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. **Result with Valid Inference/Quality of Output (10 Marks)**

    - Accuracy of Results: Precision and correctness of the obtained results.
    - Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. **Viva Voce (10 Marks)**

    - Ability to explain the experiment, procedure results and answer related questions
    - Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. **Record (5 Marks)**

    - Completeness, clarity, and accuracy of the lab record submitted

## SEMESTER S4

# MICROCONTROLLER LAB

| | | | |
|---|---|---|---|
| **Course Code** | **PCECL408** | **CIE Marks** | 50 |
| **Teaching Hours/Week (L: T:P: R)** | 0:0:3:0 | **ESE Marks** | 50 |
| **Credits** | 2 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | PCECL307-Logic Circuit Design and Simulation Lab | **Course Type** | Lab |

**Course Objectives:**

1. To learn Microcontroller Programming using Assembly and C language
2. To learn Microcontroller interfaces to various modules
3. To learn any advanced microcontrollers like ARM or higher.
4. To learn Embedded System Design

### Details of Experiment

| Expt. No. | Experiments |
|---|---|
| | **PART A – Data manipulation experiments using Assembly language(Min 4 has to be completed)** |
| **1** | Multiplication of two 16-bit numbers. |
| **2** | Largest/smallest from a series. |
| **3** | Sorting (Ascending/Descending) of data. |
| **4** | Matrix addition. |
| **5** | LCM and HCF of two 8-bit numbers. |
| **6** | Code conversion – Hex to Decimal/ASCII to Decimal and vice versa. |
| | **PART B - Interface to Microcontroller Assembly/C language (Min 3 has to be completed)** |
| **1** | Time delay generation and relay interface. |
| **2** | Display (LED/Seven segments/LCD) and keyboard interface. |
| **3** | ADC interface. |
| **4** | DAC interface with waveform generation. |
| **5** | Stepper motor and DC motor interface. |

| | PART C - Interface with Advanced Microcontroller using C language (Min 3 has to be completed) |
|---|---|
| **1** | PWM generation for DC motor control. |
| **2** | Object/Visitor Counter. |
| **3** | UART interface to Bluetooth. |
| **4** | SPI/I2C interface to display. |
| **5** | Real-time clock. |

* A minimum of 12 experiments is to be completed.

## Course Assessment Method
## (CIE: 50 marks, ESE: 50 marks)

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment) | Internal Examination | Total |
|---|---|---|---|
| **5** | **25** | **20** | **50** |

**End Semester Examination Marks (ESE):**

| Procedure/ Preparatory work/Design/ Algorithm | Conduct of experiment/ Execution of work/ troubleshooting/ Programming | Result with valid inference/ Quality of Output | Viva voce | Record | Total |
|---|---|---|---|---|---|
| **10** | **15** | **10** | **10** | **5** | **50** |

- ***Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.***
- ***Endorsement by External Examiner:*** *The external examiner shall endorse the record*

## Course Outcomes (COs)

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

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Develop 8051 Microcontroller programs | **K4** |
| **CO2** | Design and implement various interfaces to the 8051 Microcontroller | **K4** |
| **CO3** | Design and implement an Embedded System using a 8051 microcontroller | **K4** |
| **CO4** | Design and implement an Embedded System using an ARM processor | **K4** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

### CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | | | | | | | | 2 |
| **CO2** | 3 | 3 | 3 | 2 | 3 | | | 2 | | | | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

*1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

| Text Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | The 8051 Microcontroller and Embedded Systems Using Assembly and C | Muhammad Ali Mazidi<br>Janice Gillispie Mazidi<br>Rolin D. McKinlay | Printice Hall -Inc | Second, 2007 |
| 2 | The 8051 Microcontroller Architecture, Programming and Applications | Kenneth J Ayala<br>Dhananjay V Gadre | Cengage Learning | 2010 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | 8051 Hardware Description | Datasheet | Intel Corporation | 1992 |
| **2** | Microprocessors and Microcontrollers | Lyla B. Das | Pearson Education | 2011 |
| **3** | ARM System-on-Chip Architecture | Steve Furber | Addison-Wesley Educational Publishers Inc | 2000 |
| **4** | System-on-Chip Design with Arm(R) Cortex(R)-M Processors | Joseph Yiu | ARM Education Media | 2019 |

| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **Module No.** | **Link ID** |
| **1** | Microprocessors and Microcontrollers - https://nptel.ac.in/courses/106108100 |
| **2** | Microcontrollers and Applications - https://nptel.ac.in/courses/117104072 |
| **3** | Embedded System Design With ARM - https://onlinecourses.nptel.ac.in/noc22_cs93 |

## Continuous Assessment (25 Marks)

1. **Preparation and Pre-Lab Work (7 Marks)**
   - Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
   - Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.
2. **Conduct of Experiments (7 Marks)**
   - Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
   - Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
   - Teamwork: Collaboration and participation in group experiments.
3. **Lab Reports and Record Keeping (6 Marks)**
   - Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.

- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. **Viva Voce (5 Marks)**
    - Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

***Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.***

## Evaluation Pattern for End Semester Examination (50 Marks)

1. **Procedure/Preliminary Work/Design/Algorithm (10 Marks)**
    - Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
    - Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
    - Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
    - Creativity and logic in algorithm or experimental design.

2. **Conduct of Experiment/Execution of Work/Programming (15 Marks)**
    - Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. **Result with Valid Inference/Quality of Output (10 Marks)**
    - Accuracy of Results: Precision and correctness of the obtained results.
    - Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. **Viva Voce (10 Marks)**
    - Ability to explain the experiment, procedure results and answer related questions
    - Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. **Record (5 Marks)**

- Completeness, clarity, and accuracy of the lab record submitted

## SEMESTER 4

# LINEAR ALGEBRA FOR COMMUNICATION

| | | | |
|---|---|---|---|
| **Course Code** | HNECT409 | **CIE Marks** | 40 |
| **Teaching Hours/Week (L:T:P)** | 3:1:0 | ESE Marks | 60 |
| **Credits** | 4 | Exam Hours | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | GYMAT101 | Course Type | Theory |

**Course Objectives:**

1. Develop a Rigorous Understanding of Linear Algebraic Structures and Transformation
2. Apply Linear Algebra Techniques to Real-World Problems and Computational Context

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| **1** | Review of linear systems of equations and matrix algebra ([1] Ch. 1 and 2) Vector Spaces and Subspaces, Null Spaces, Column Spaces, and Linear Transformations, Linearly Independent Sets; Bases, The Dimension of a Vector Space, Rank, Applications to Difference Equations, Applications to Markov Chains ([1] Ch. 4) | **11** |
| **2** | Eigenvectors and Eigenvalues, The Characteristic Equation, Similarity, Diagonalization, Eigenvectors and Linear Transformations, Complex Eigenvalues, Discrete Dynamical Systems, Applications to Differential Equations ([1] Ch. 5) | **11** |
| **3** | Inner Product, Length, and Orthogonality, Orthogonal Sets, Orthogonal Projections, The Gram–Schmidt Process, Least-Squares Problems, Applications to Linear Models, Inner Product Spaces, Applications of Inner Product Spaces ([1] Ch. 6) | **11** |

| | | |
|---|---|---|
| **4** | Diagonalization of Symmetric Matrices, Quadratic Forms, Constrained Optimization, The Singular Value Decomposition, Applications to Image Processing and Statistics ([1] Ch. 7) | **11** |

Suggested Assignment/Microproject: Use Numpy/Matplotlib packages to practice and visualize Linear Algebraic operations

**Course Assessment Method**
**(CIE: 40 marks, ESE: 60 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment/ Microproject | Internal Examination-1 (Written) | Internal Examination- 2 (Written ) | Total |
|---|---|---|---|---|
| **5** | **15** | **10** | **10** | **40** |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 sub divisions.<br>**(4x9 = 36 marks)** | **60** |

**Course Outcomes (COs)**

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

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Analyze vector spaces and subspaces, apply concepts such as rank, null space, and linear transformations, and apply these to difference equations and Markov chains | **K3** |
| **CO2** | Compute eigenvalues and eigenvectors, perform matrix diagonalization and similarity transformations, and apply these techniques to analyze linear transformations and discrete dynamical systems, including applications to differential equations. | **K3** |

| | | |
|---|---|---|
| **CO3** | Apply inner product concepts to construct orthogonal bases using the Gram–Schmidt process, solve least-squares problems, and interpret linear models through projections and orthogonality in inner product space | **K3** |
| **CO4** | Diagonalize symmetric matrices, analyze quadratic forms and constrained optimization problems, and apply singular value decomposition (SVD) to practical problems in image processing and statistical data analysis | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | | **2** | | | | | | | | **2** |
| **CO2** | **3** | **3** | | **2** | | | | | | | | **2** |
| **CO3** | **3** | **3** | | **2** | | | | | | | | **2** |
| **CO4** | **3** | **3** | | **2** | | | | | | | | **2** |

| **Text Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Linear Algebra and its Applications | David C Lay | Pearson | 5e, 2016 |
| **2** | Linear Algebra and its Applications | Gilbert Strang | Cengage Learning | 5e, 2018 |

| **Reference Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Introduction to Applied Linear Algebra Vectors, Matrices, and Least Squares | Stephen Boyd | Cambridge University Press | 1e, 2018 |
| **2** | Matrix Analysis and Applied Linear Algebra | Carl D Meyer | Siam | 1e, 2000 |

# MODEL QUESTION PAPER

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**
**FOURTH SEMESTER B. TECH HONOURS DEGREE EXAMINATION, MONTH AND YEAR**

**Course Code:** HNECT409

**Course Name: Linear Algebra for Communication**

| Max. Marks: 60 | | Duration: 2 hours 30 minutes |
|---|---|---|

**PART A**

| | | *Answer all questions. Each question carries 3 marks* | CO | Marks |
|---|---|---|---|---|
| 1 | | Consider the system of linear equations $Ax = b$ where $A$ is a $3 \times 5$ matrix with rank = 3. What can you say about the existence and uniqueness of solution? Explain your reasoning. | 1 | (3) |
| 2 | | Define subspace of a vector space. | 1 | (3) |
| 3 | | What is meant by the geometric and algebraic multiplicity of an eigenvalue. | 2 | (3) |
| 4 | | Show that the eigenvalues of a triangular matrix are the entries on the diagonal. | 2 | (3) |
| 5 | | Find a non-zero vector orthogonal to $u_1 = [1,2,1], u_2 = [2,5,4]$ in $R^3$. | 3 | (3) |
| 6 | | Prove the Pythagorean theorem for orthogonal vectors. | 3 | (3) |
| 7 | | What do you mean by the positive definiteness of a quadratic form? | 4 | (3) |
| 8 | | Give the singular value decomposition of a matrix A. What can you say about the factors in the SVD? | 4 | (3) |

**PART B**

***Answer any one full question from each module. Each question carries 9 marks***

**Module 1**

| | | | | |
|---|---|---|---|---|
| 9 | a) | Check whether the following vectors form a basis for the space spanned by them $v1 = \begin{bmatrix}1\\2\\3\end{bmatrix}, v2 = \begin{bmatrix}4\\5\\6\end{bmatrix}, v3 = \begin{bmatrix}2\\1\\0\end{bmatrix}$ | 1 | 4 |
| | b) | What is meant by null space of a linear transformation? Find the null space of the linear transformation $C = \begin{bmatrix}1 & 1\\1 & 1\end{bmatrix}$. | 1 | 5 |
| 10 | a) | Let V be the first quadrant in x-y plane; that is, $V = \left\{\begin{bmatrix}x\\y\end{bmatrix} : x \geq 0, y \geq 0\right\}$. Is V a subspace of $\mathbb{R}^2$? | 1 | 4 |
| | b) | Express the polynomial $v = 3t^2 + 5t - 5$ as a linear combination of the polynomials $p_1 = t^2 + 2t + 1$, $p_2 = 2t^2 + 5t + 4$, $p_3 = t^2 + 3t + 6$ | 1 | 5 |

| | | | | |
|---|---|---|---|---|
| | | **Module 2** | | |
| 11 | a) | Find the $2 \times 2$ linear transformation matrix $A$ that reflects a point in the x-y plane about the x-axis. Intuitively find the eigenvectors and corresponding eigenvalues of A without actually computing them. Explain your reasoning. Check if $A^2 = I$. Justify your finding. | 2 | 5 |
| | b) | Prove that an $n \times n$ matrix is diagonalizable if and only if it has $n$ linearly independent eigenvectors. | 2 | 4 |
| 12 | a) | Find the eigenvalues and eigenvectors of the matrix $C = \begin{bmatrix} 1 & -1 \\ 1 & 1 \end{bmatrix}$. | 2 | 4 |
| | b) | Show that if $\{\lambda, \boldsymbol{x}\}$ is an eigenpair for real matrix $A$, then so is $\{\bar{\lambda}, \bar{\boldsymbol{x}}\}$, where overbar denotes complex conjugate | 2 | 5 |
| | | **Module 3** | | |
| 13 | a) | Let $\{u_1, .. u_p\}$ be an orthogonal basis for a subspace W of $R^n$. Obtain the matrix for projecting a vector y onto W | 3 | 4 |
| | b) | Let W=span{x1, x2} where x1=[3, 6, 0]$^T$ and x2=[1, 2, 2]$^T$. Construct an orthogonal basis for W | 3 | 5 |
| 14 | a) | Show that transformation by an orthogonal matrix preserves norms and angles | 3 | 4 |
| | b) | Show that the least-squares solution of a set of linear equations coincide with the solution for the normal equations | 3 | 5 |
| | | **Module 4** | | |
| 15 | a) | Obtain the spectral decomposition of a symmetric matrix A | 4 | 4 |
| | b) | State five properties of a symmetric matrix | 4 | 5 |
| 16 | a) | Show that for a symmetric matrix A, any two eigenvectors from different eigenspaces are orthogonal | 4 | 4 |
| | b) | Let A be a symmetric matrix. Show that $x^T Ax$ is maximised (subject to $\|x\| = 1$) when $x$ is an eigenvector of A corresponding to the largest eigenvalue | 4 | 5 |
| | | ***** | | |