SEMESTER 6

APPLIED ELECTRONICS AND INSTRUMENTATION

SEMESTER S6

ELECTRIC DRIVES AND CONTROL

Course Code	PCAET601	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)	GXEST104 Introduction to Electrical and Electronics Engineering	Course Type	Theory

Course Objectives:

1. To study and analyze various electrical drives and its control.
2. To design and analyze various power converter circuits for various applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**DC and AC Machines** DC machines – Principle of operation of DC generator, constructional details, EMF equation, types of generators. Principle of operation of DC motors. Electrical and mechanical characteristics of DC series, shunt and compound motors, applications. AC machines – Principle of operation, rotating magnetic field, single phase and three phase induction motors.	11
2	**Power Devices and Controlled Rectifiers** Power devices – Power BJT, power MOSFET and IGBT - steady state and switching characteristics. Drive requirements. Design of simple drive circuits for power BJT, power MOSFET and IGBT. Principle of DC motor control. Principle of PWM switching control. Two quadrant and four quadrant converter circuit. Controlled rectifiers – Principle of phase controlled converter operation. Single phase half wave and full wave controlled rectifiers with R, RL and battery loads.	12

3	**Inverters** Single phase inverters - half bridge, full bridge and push pull inverter, Three phase voltage source inverter. Fundamental concepts of PWM schemes, Sine triangle PWM, Space vector PWM, harmonic distortion factors for three phase inverters.	**10**
4	**Induction Motor Drives and Vector Control Techniques** Induction motor drives – Torque-speed characteristics of induction motor, Speed control by varying stator frequency and voltage. Voltage source inverter driven induction motor, application of PWM for induction motor drive. Vector Control Techniques – Concepts of Direct Torque Control (DTC), Field Oriented Control (FOC), Comparison of vector control and scalar control. Application of Vector control drives.	**11**

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. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(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 of DC Machines and AC Machines	**K3**
CO2	Analyze the behavior of Power devices and Controlled Rectifier circuits	**K4**
CO3	Design and analyze Inverter circuits	**K4**
CO4	Understand and analyze induction motor drives and vector control techniques	**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	2									3
CO2	3	3	2									3
CO3	3	3	2									3
CO4	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	Theory and performance of Electrical Machines	J B Gupta	SK Kataria and Sons	15th Edition, 2015
2	Power Electronics: Essentials and Applications	L. Umanand	Wiley India Pvt. Ltd.	1st Edition, 2009
3	Power Electronics: Converters Application and Design	Ned Mohan, Tore M . Undeland, William P. Robbins	John Wiley and Sons	3rd Edition, 2002

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	A Textbook of Electrical Technology. AC and DC Machines (Volume II)	B.L Theraja and A.K Theraja	S Chand and Company Ltd	Multicolor Edition, 2020 Reprint
2	Electric Motor Drives, Modeling Analysis and Control	R. Krishnan	PHI	1st Edition, 2001
3	Power Electronics: Circuits, Devices and Applications	Mohammad H Rashid	Pearson	4th Edition, 2017

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/108/104/108104140/ https://nptel.ac.in/courses/108108077
2	https://archive.nptel.ac.in/courses/108/104/108104140/ https://nptel.ac.in/courses/108108077
3	https://archive.nptel.ac.in/courses/108/104/108104140/ https://nptel.ac.in/courses/108108077
4	https://archive.nptel.ac.in/courses/108/104/108104140/ https://nptel.ac.in/courses/108108077

SEMESTER S6

INDUSTRIAL INSTRUMENTATION

Course Code	**PCAET602**	**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)	PCAET303 Transducers and Measurements	**Course Type**	Theory

Course Objectives:

1. To understand the working of different types of temperature, pressure, displacement, level and flow sensors

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Temperature Measurement** Resistance Thermometers – Linear approximation and quadratic approximation, principle of operation. Thermistors – Construction, characteristics, applications, Resistance Temperature detectors. Thermocouples – Laws, types, comparisons with other temperature sensors. Thermopiles, Different types of pyrometers, Infrared guns, electronic temperature switches, fluidic sensors, Johnson noise thermometer, Humidity and moisture measurement.	**9**
2	**Pressure and displacement Measurement** Mechanical devices – Bellows, Bourdon tube, diaphragm, types of variable inductance and capacitance, strain gauge and its types, piezo electric type, potentiometric type, mano meters. Low pressure and vaccum measurements – Pirani gauge, McLeod gauge, ionization gauge. Differential Pressure Transmitters – Pneumatic transmitter. Displacement measurements – LVDT, RVDT, Proximity sensors, Hall effect devices.	**9**

3	**Flow and Viscosity Measurement** Differential pressure flow meters – Laminar and turbulent flow, Bernoulli's theorem, Orifice plate, Venturi Tubes and Nozzles, Pitot Tubes. Positive Displacement Flowmeters – Reciprocating piston meters, Oval gear meters, Nutating disc flow meter. Mass Flowmeters – Radiation type, Angular Momentum type, Impeller Turbine Flow meter, Constant torque type. Electromagnetic and ultrasonic flow meter. Measurement of Viscosity – Principle, Newtonian fluids, Viscometer types – Saybolt and Red wood. Capillary Viscometers – Differential Pressure type.	**9**
4	**Level and Turbidity Measurement** Level Measurement Methods – Dip stick, Sight glass, Float Type level indicator, Ball float, hydrostatic pressure level sensor. Displacer Type – Torque tube assembly. Electrical Methods – Resistance, Conductance, Inductive and Capacitive level gauging. Ultrasonic Method, Microwave Level Switches, Non-contacting optical level sensor, Rotating Paddle Switches, laser sensor. Turbidity Measurement – Electronic turbidity meters.	**9**

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. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(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	Understand the working of different types of temperature sensors	**K2**
CO2	Illustrate the various types of pressure and displacement measurement techniques	**K2**
CO3	Analyze the working of various flow and viscosity measurement devices	**K4**
CO4	Illustrate the different types of level and turbidity sensors	**K2**

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						2				3
CO2	3	3						2				3
CO3	3	3						2				3
CO4	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	A course in Electrical and Electronic Measurements and Instrumentation	A K. Sawhney	Dhanpat Rai & Co. Limited	2/e, 2015
2	Principles of Industrial Instrumentation	D Patranabis	Tata McGraw Hill	3/e, 2017
3	Industrial Instrumentation & Control	S. K. Singh,	Tata McGraw Hill	3/e, 2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Applied Instrumentation in the Process Industries – A survey	Andrew W.G,	Gulf Publishing Company	2001
2	Process / Industrial Instruments & Controls Handbook	Douglas M. Considine	McGraw Hill	5/e, 2009
3	Flow measurement, 2nd Edition 1995.	Spitzer D. W.,	Butterworth Heinemann	2nd Edition, 1995
4	Instrumentation Reference Book	Noltingk B.E.	Butterworth Heinemann	2/e, 2013

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/108105064
2	https://nptel.ac.in/courses/108105064
3	https://nptel.ac.in/courses/108105064
4	https://archive.nptel.ac.in/courses/103/105/103105130/

SEMESTER S6

CMOS CIRCUIT DESIGN

Course Code	**PEAET631**	**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)	PCAET302: Electronic Devices and Circuits	**Course Type**	Theory

Course Objective:

1. This course aims to impart the basic knowledge of CMOS analog circuits design and enable the students to design integrated circuits.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Basic MOS Device physics** - Review of MOS Characteristics and Second order effects (only basic theoretical concepts). **Single Stage Amplifiers**. Common Source Stage with Different Load types , Source Follower, Common Gate and Cascode Stage	9
2	**Differential Amplifiers** - Single-ended and differential operation, Basic differential pair, Common-mode response, Differential pair with MOS load, Gilbert Cell. **Current Mirror**: Simple, Cascode and Basic concepts of active current Mirror.	9
3	**Frequency Response of Amplifiers:** Miller Effect, Poles and Zeros, Frequency Response Analysis of Common Source, Source Follower, Common Gate and Differential Pair.	9
4	**Phase Locked Loops -** Mathematical model of VCO, Phase Detector, Basic PLL Topology, Type I and Type II(Charge Pump) PLL, Stability Analysis of PLL, Non Ideal Effects in PLL, Application of PLL - Frequency Multiplication, Frequency synthesizer and Skew reduction. Block Diagram of Digital PLL.	9

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. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(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 various Single stage Amplifiers with different types of loads	K3
CO2	Design and Analyse Differential Amplifiers	K3
CO3	Design various types of current mirrors	K3
CO4	Analyze the frequency response of single stage and differential amplifiers	K3
CO5	Implement PLL for various applications	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			2							3
CO2	3	2	2	2	2							3
CO3	3	2	2	2	2							3
CO4	3	2	2	2	2							3
CO5	3	2	2	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	Design of Analog CMOS Integrated Circuits	Behzad Razavi	McGraw-Hill	2/e, 2017
2	CMOS Digital Integrated Circuits, Analysis and Design	Sung-Mo Kang, Yusuf Leblebici, Chulwoo Kim	McGraw-Hill	Revised 4/e, 2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	CMOS Analog Circuit Design	Phillip E. Allen, Douglas R. Holbery	Oxford	2004
2	CMOS: Circuits Design, Layout and Simulation	R. Jacob Baker	Wiley	2nd edition, 2009
3	CMOS: Circuit Design, Layout and Simulation (IEEE Press Series on Microelectronic Systems)	R. Jacob Baker	Wiley-IEEE Press	4th edition, 2019

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/117/101/117101105/ https://archive.nptel.ac.in/courses/108/107/108107129/
2	https://archive.nptel.ac.in/courses/117/101/117101105/ https://archive.nptel.ac.in/courses/108/107/108107129/
3	https://archive.nptel.ac.in/courses/117/101/117101105/ https://archive.nptel.ac.in/courses/108/107/108107129/
4	https://archive.nptel.ac.in/courses/117/101/117101105/ https://archive.nptel.ac.in/courses/108/107/108107129/

SEMESTER S6

INSTRUMENTATION FOR AGRICULTURE

Course Code	**PEAET632**	**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)	PCAET303 Transducers and Measurements	**Course Type**	Theory

Course Objectives:

1. To explain and apply fundamental principles of agricultural instrumentation to monitor key parameters
2. Describe the function and importance of different soil sensors and demonstrate their use in real-world agricultural scenarios.
3. To analyze and classify different soil types (sandy, clay, silt, loamy) based on their characteristics and evaluate their suitability for various agricultural practices.
4. Able to evaluate and optimize various agricultural practices, such as irrigation methods and greenhouse climate control, using data collected from sensors and environmental monitoring systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Agricultural Instrumentation and Soil Types** Fundamentals of Agricultural Instrumentation, Importance of instrumentation and control in agriculture. Overview of precision agriculture and smart farming. Agricultural parameters to be monitored - soil moisture, temperature, humidity, pH, nutrient levels, light intensity, and CO_2 levels. Classification and characteristics of different soil types - sandy, clay, silt. Loamy soil. Soil Monitoring Systems - Soil Sensors - Soil moisture sensor, capacitive sensors. Soil temperature sensors - thermocouples, RTDs, thermistors. Gypsum block soil moisture sensors. Soil pH sensors - ion-selective electrodes.	9

2	Water Quality Parameters - pH, electrical conductivity, dissolved oxygen, turbidity. Basic principles of water quality sensors. Irrigation Systems - Necessity and methods - overhead, center pivot, lateral move, micro irrigation systems, irrigation scheduling, and irrigation efficiencies (basic concepts only).	**9**
3	Greenhouse Monitoring and Climate Control. Basics of Greenhouses - Introduction to greenhouse structures and their importance. Environmental control in greenhouses - temperature, humidity, light, and CO_2 management. Environmental Sensors – hair hygrometer, dry and wet bulb hygrometer. Light sensors - photodiodes, pyranometers. CO_2 sensors - NDIR sensors. Microclimate Monitoring, Importance of microclimate in greenhouse and field agriculture.	**9**
4	Plant growth monitoring - Leaf area, length, evapotranspiration, wetness & respiration measurement, electromagnetic radiations photosynthesis, infrared & UV bio sensor methods in agriculture. Weather Stations - Components and functionality - Anemometers, sonic anemometers, surface flux measurement. Ground water occurrence - confined and unconfined aquifers Introduction to vertical farming and hydroponics.	**9**

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. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(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	Understand the necessity and fundamentals of instrumentation in agriculture	**K2**
CO2	Illustrate learn about different soil and water parameters and their properties	**K2**
CO3	Familiarize various sensors and their applications in monitoring agricultural parameters	**K2**
CO4	Design and implement effective soil and environmental monitoring 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	2	2		3	3	3					3
CO2	3	2	2		3	3	3					3
CO3	3	2	2		3	3	3					3
CO4	3	2	3		3	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	Process Control and Instrumentation Technology	Curtis D. Johnson	Pearson Education India	8th edition 2015
2	Industrial Instrument and Control	S K Singh	McGraw Hill Education	3rd Edition 2017
3	Textbook of Soil Science	T. Biswas, S Mukherjee	McGraw Hill Education	2nd edition 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Textbook on Fundamentals of Soil Science	M. Yuvaraj	Brillion Publishing	2023
2	Agricultural Automation: Fundamentals and Practices	Francis J. Pierce, Qin Zhang	CRC Press	2013
3	Process Control: Instrument Engineers' Handbook	Béla G. Lipták	Butterworth-Heinemann	2013

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/126/105/126105016/
2	https://archive.nptel.ac.in/courses/126/105/126105019/
3	https://www.youtube.com/watch?v=xT1Nlyo_CxI
4	https://onlinecourses.nptel.ac.in/noc24_ag10/preview

SEMESTER S6

DISCRETE CONTROL SYSTEMS

Course Code	**PEAET633**	**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)	PCAET501: Control System Theory	**Course Type**	Theory

Course Objectives:

1. To understand the signal conversion and processing involved in discrete data control systems
2. To carry out stability analysis of discrete time control systems
3. To acquire knowledge in state space representation of systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to DCS** Basic Elements of discrete data control systems, advantages of discrete data control systems, examples. Signal conversion & processing: Digital signals & coding, data conversion & quantization, sample and hold devices. Mathematical modelling of the sampling process, Design of maximum sampling frequency of digital systems in terms of the sensor delay; Data reconstruction and filtering of sampled signals: Zero Order hold & First order Hold.	9
2	**Discrete Time Control Systems** Pulse transfer function, Z transform analysis of closed loop and open loop systems- Steady state error analysis of digital systems- Examples on static error coefficients. Bilinear transformation- mapping from s-plane to z-plane	9
3	**Analysis of Discrete Time Control Systems** Stability analysis of linear digital control systems - Routh Hurwitz criteria, Jury's test. Root loci of digital control systems - rules for construction of root	9

	locus. Frequency domain analysis - Bode plots- Gain margin and Phase margin.	
4	**State Space Analysis** State space representation of discrete time systems- State space model- various canonical forms from transfer function, Conversion of transfer function model to state space model, Discrete time State transition matrix, Solution of discrete state equations, Controllability and Observability, Pole placement using state feedback.	**9**

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. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(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	Understand the basic elements, their functions and Interconnections in a digital control system.	**K2**
CO2	Develop the pulse transfer function and steady state error analysis of digital control systems	**K3**
CO3	Understand frequency domain analysis and analyse stability of linear digital control systems.	**K3**
CO4	Develop state space representation of discrete time systems and find solution of state equation.	**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	2	2								2
CO2	3	3	3	2								2
CO3	2	3	3	3	3							2
CO4	3	3	3	3								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	Discrete- Time Control Systems	Katsuhiko Ogata	Prentice Hall of India, 2005	2nd Edition, 2005
2	Digital control systems	B. C. Kuo	Oxford University Press	2nd Edition, 2007
3	Digital Control and State variable methods	M. Gopal	Tata McGraw Hill	4th Edition, 2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Continuous & Discrete Control Systems	John Dorsey	Tata McGraw Hill	2001
2	Modem Control Systems	Richard C Dorf and Robert H. Bishop	Pearson Education	2001

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/108103008
2	https://nptel.ac.in/courses/108103008
3	https://nptel.ac.in/courses/108103008
4	https://nptel.ac.in/courses/108103008

SEMESTER S6

AUTOMOTIVE ELECTRONICS

Course Code	**PEAET634**	**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)	PCAET501 Control System Theory	**Course Type**	Theory

Course Objectives:

1. To illustrate Electronic Engine control system and cruise control systems.
2. To analyse various automotive electronic systems, hybrid drives and power management systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Basics of Electronic Engine Control** Overview of electronics in vehicles, Need for Electronic Engine Control, Concept of an Electronic Engine Control System, Inputs and outputs to engine control system, Electronic Fuel Control System, Closed Loop Electronic Fuel Control System and Electronic Ignition System	**8**
2	**Vehicle Motion Controls** Representative Cruise Control System – Digital Cruise Control Configuration and block diagram, cruise control speed performance. Digital speed control. Cruise Control Electronics - Basic concepts of Stepper Motor based and Vacuum Operated Actuator. Basics of Antilock Braking System, Electronic Suspension Control System and Electronic Steering Control.	**10**
3	**Power Systems and Hybrid Drives** Battery management system – Battery types and its maintenance, Capacity Rating, Battery charging methods, Battery tests. Modern battery types -	**10**

	Lithium-ion battery, Fuel cells, Ultra capacitors. Charging System – Basic charging system principle, Alternator in vehicles, rectification of AC to DC, Example of charging circuit, smart charging. Engine Starting system – Introduction, starting requirements, block diagram of starting system, electronic starter control Concept of Electric vehicles, Hybrid Drive concept, Types of hybrid – series, parallel, micro, mild and strong hybrid. Concept of Recuperative brake system.	
4	**Automotive Instrumentation and Diagnostics** Modern Automotive Instrumentation – General and computer based instrumentation system, Advantages of Computer-Based Instrumentation. Fuel Level Measurement and Indication, Vehicle Speed Measurement, High-Speed Digital Communications - CAN Protocol (Basics concepts only), Trip Information Computer, Airbag deployment. Electronic Control System Diagnostics, Service Bay Diagnostic Tool, On-board Diagnosis (OBD II)	**8**

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. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(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	Demonstrate the working of electronic engine control systems	**K2**
CO2	Illustrate the cruise control systems	**K2**
CO3	Design the power systems and hybrid drive for vehicles.	**K3**
CO4	Understand the automotive instrumentation systems and vehicle diagnostics	**K2**

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	2	3									3
CO2	3	2	3									3
CO3	3	2	3									3
CO4	3	2	3									3

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Understanding Automotive Electronics: An Engineering Perspective	William B. Ribbens	Butterworth-Heinemann Inc	8th Edition, 2017
2	Bosch Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive	Bosch	Springer	5th Edition, 2013
3	Automobile Electrical and Electronic Systems	Tom Denton	Elsevier	3rd Edition, 2004

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Automotive Electronics Design Fundamentals	Najamuz Zaman	Springer	1st Edition, 2015
2	Automotive Electrical and Electronics	A K Babu	Khanna Book Publishing	2nd Edition, 2017
3	Hillier's Fundamentals of Motor Vehicle Technology	V.A.W Hillier	Oxford	6th Edition, 2012
4	Automotive Electrical Equipment	P L Kohli	McGraw Hill	1st Edition, 2017
5	Automotive Electricity and Electronics	Barry Hollembeak	Cengage Learning	7th Edition, 2018

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/107/106/107106088/
2	https://archive.nptel.ac.in/courses/107/106/107106088/
3	https://archive.nptel.ac.in/courses/107/106/107106088/
4	https://archive.nptel.ac.in/courses/107/106/107106088/

SEMESTER S6

BIOMEDICAL IMAGING

Course Code	PEAET636	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)	PCECT402 Signals and Systems	Course Type	Theory

Course Objectives:

1. To introduce the fundamental concepts of biomedical imaging and its analysis.
2. To understand various medical imaging modalities and their applications.
3. To learn techniques for image enhancement, segmentation, and analysis.
4. To apply image analysis techniques to real-world biomedical problems.
5. To gain practical experience through laboratory exercises and projects.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Biomedical Imaging -** Introduction to Biomedical Image Analysis, Medical Imaging Modalities- X-ray, CT, MRI, Ultrasound, PET and Microscopy. Image Acquisition and Reconstruction, Image Storage, Retrieval, and Communication - Applications of Biomedical Imaging	9
2	**Image Pre-processing and Enhancement** Image Pre-processing- Noise Reduction, Smoothing, and Filtering - Image Enhancement Techniques - Histogram Equalization, Contrast Stretching, Homomorphic Filtering, and Multiresolution Analysis - Edge Detection Techniques: Sobel, Canny, and Laplacian - Image Restoration and De-noising Techniques.	9
3	**Image Segmentation and Feature Extraction** Image Segmentation Techniques - Thresholding, Region Growing, and Clustering - Advanced Segmentation Methods: Watershed, Level Set, and Graph Cut - Feature Extraction: Shape, Texture, and Intensity-based features - Feature Selection and Dimensionality Reduction Techniques.	9

4	**Image Analysis and Applications** Image Classification Techniques - Supervised and Unsupervised Learning - Pattern Recognition and Machine Learning in Biomedical Image Analysis - Case Studies: Tumor Detection, Organ Segmentation, and Disease Diagnosis - Evaluation Metrics for Image Analysis: Sensitivity, Specificity, and ROC Curves - Current Trends and Future Directions in Biomedical Image Analysis	**9**

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. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(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	Understand the principles of various biomedical imagingmodalities	**K2**
CO2	Apply image pre-processing and enhancement techniques	**K3**
CO3	Perform image segmentation and feature extraction for biomedical applications	**K4**
CO4	Analyze biomedical images using classification and pattern recognition techniques	**K4**
CO5	Evaluate the performance of image analysis methods in real-world biomedical problems	**K5**

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	2									3
CO2	3	3	3	2								3
CO3	3	3	3	2	2							3
CO4	3	3	3	3	2							3
CO5	3	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	Biomedical Image Analysis	Rangaraj M. Rangayyan	CRC Press	2004
2	Digital Image Processing	Rafael C. Gonzalez, Richard E. Woods	Pearson Education	4th Edition, 2018
3	Medical Image Processing, Reconstruction and Restoration	Jiri Jan	CRC Press	2005
4	Medical Imaging Signals and Systems	Jerry L. Prince, Jonathan Links	Pearson Education	2006

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Image Processing, Analysis, and MachineVision	Milan Sonka, Vaclav Hlavac, Roger Boyle	Cengage Learning	4th Edition, 2014
2	Pattern Recognition and Machine Learning	Christopher Bishop	Springer	2006
3	Medical Image Analysis	Atam P. Dhawan	Wiley-Interscience	2003
4	Handbook of MedicalImaging	Jacob Beutel, Harold L. Kundel, Richard L. Van Metter	SPIE Press	2000

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Introduction to Biomedical Imaging: NPTEL Lecture Series by Prof. Arun Kumar Thittai
2	Image Processing Techniques: NPTEL Course on Digital Image Processing by Prof. P. K. Biswas
3	Advanced Image Segmentation: NPTEL Course on Medical Image Analysis by Ganapathy Krishnamurthi
4	Machine Learning in Medical Imaging: NPTEL Course on Deep Learning for Computer Vision by Prof. Vineeth N Balasubramanian

SEMESTER S6

DIGITAL IMAGE PROCESSING

Course Code	**PEAET635**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	5/3	**Exam Hours**	2 Hrs.30 Min.
Prerequisites (if any)	PBECT504 Digital Signal Processing	**Course Type**	Theory

Course Objectives:

1. To establish a theoretical foundation for fundamental concepts in Digital Image Processing
2. Comprehend the algorithms utilized in two-dimensional signal processing.
3. Apply image processing techniques to address engineering challenges.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Digital Image Fundamentals -** Image representation, basic relationship between pixels, elements of DIP system, elements of visual perception- simple image formation model. Digital Camera working principles Brightness, Contrast, Hue, Saturation. Colour image fundamentals - RGB, CMY, HIS models, 2D sampling, Quantization. Review of matrix theory - Row and column ordering - Toeplitz, Circulant and block matrix.	9
2	**2D Image transforms -** DFT and its properties, DCT, KL transform and Singular Value Decomposition. Image Enhancement - Spatial domain methods - point processing- intensity transformations, histogram processing, image subtraction, image averaging. Spatial filtering- smoothing filters, sharpening filters. Frequency domain methods - low pass filtering and high pass filtering.	9
3	**Image Restoration** - Degradation model, Unconstrained restoration- Lagrange multiplier and constraint restoration	9

	Inverse filtering - removal of blur caused by uniform linear motion. Feature Extraction - Introduction to feature extraction techniques-Harris corner detection, SIFT	
4	Feature descriptors - Histogram of Oriented Gradients (HOG), Scale Invariant Features Image Classification - Support Vector Machine, Decision Trees, Object Detection using **HOG, Object Detection using Viola-Jones Algorithm.** Image Segmentation - Thresholding, Region-based segmentation, Clustering techniques (k-means). Morphological Operations - Dilation and Erosion, Opening and Closing, Hit-or-Miss transformation, Boundary Extraction, Region filling,	**9**

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Internal Ex	Evaluate	Analyse	Total
5	**15**	**10**	**10**	**40**

Criteria for Evaluation (Evaluate and Analyze): 20 marks

- Each student should design, implement, and analyze a digital image processing system for various applications.
- System development can be accomplished using
  - Python: OpenCV, NumPy, Scikit-image
  - MATLAB: Image Processing Toolbox
- **Each student should do minimum two microprojects from each of the below Topics 1 to 5. Topic 6 is not compulsory.**

  - **Topic 1: Basic Image Manipulation**
    - Grayscale Conversion: Convert color images to grayscale.
    - Image Resizing: Implement different resizing techniques (nearest neighbor, bilinear, bicubic).
    - Image Cropping: Allow users to crop specific regions of an image.
    - Image Rotation: Rotate images by specified angles.
    - Image Flipping: Flip images horizontally or vertically.

- **Topic 2: Image Enhancement**
  - Contrast Adjustment: Adjust image contrast using linear or non-linear methods.
  - Brightness Adjustment: Modify image brightness.
  - Histogram Equalization: Enhance image contrast using histogram equalization.
  - Image Sharpening: Apply sharpening filters to enhance image details.
- **Topic 3: Image Filtering**
  - Averaging Filter: Apply a smoothing filter to reduce noise.
  - Median Filter: Remove noise while preserving edges.
  - Gaussian Blur: Create a Gaussian blur effect.
  - Edge Detection: Implement edge detection techniques (Sobel, Canny).
- **Topic 4: Image Analysis**
  - Image Segmentation: Divide an image into meaningful regions.
  - Object Detection: Detect specific objects within an image.
  - Feature Extraction: Extract relevant features from images
- **Topic 5: Image Classification**
  - Traffic Sign Recognition: Classify common traffic signs (stop, yield, speed limit, etc.).
  - Cat vs. Dog Classification: Build a model to differentiate between cat and dog images.
  - Classify fruits (apples, oranges, bananas).
- **Topic 6 (optional): Advanced Image Classification with Machine Learning**
  - Recognize different types of flowers.
  - Classify types of cars (sedan, SUV, truck).
  - Detect objects in images (faces, cars, pedestrians).

The project deliverables consist of the following components:

- Detailed design specifications
- Identification and resolution of technical challenges
- Designed and developed algorithms
- Implementation results and performance evaluations
- Comprehensive project report, incorporating methodology, results, challenges, and recommendations.

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. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• 2 questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. • Each question carries 9 marks. **(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	Identify and summarize the aspects of digital image processing.	**K2**
CO2	Demonstrate knowledge of the significance of transforms in digital image processing.	**K2**
CO3	Apply principles and techniques of image restoration, enhancement, and segmentation.	**K2**
CO4	Utilize modern principles and techniques for classifying and segmenting images.	**K3**
CO5	Model and solve engineering problems by utilizing digital image processing algorithms.	**K5**

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	2	2								3
CO2	3	2	2	2								3
CO3	3	2	2	2	2							3
CO4	3	2	2	2	2							3
CO5	3	2	3	2	2	2	2	2			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	Digital Image Processing	Gonzalez Rafel C	Pearson Education	1/e, 2009
2	Fundamentals of digital image processing	Jain Anil K	Prentice Hall	1/e, 1989
3	Foundations of Computer Vision	Antonio Torralba	MIT Press	1/e, 2024
4	Computer Vision: Algorithms and Applications	Richard Szeliski,	Springer	2/e, 2010

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital image processing	Kenneth R Castleman	Pearson Education	2/e, 2003
2	Digital image processing	Pratt William K	John Wiley	4/e, 2007
3	Hands-On Image Processing with Python	Sandipan Dey	Packt Publishing	1/e, 2024
4	Computer Vision with Python 3	Saurabh Kapur	Packt Publishing	1/e, 2017
5	Programming Computer Vision with Python	Jan Erik Solem	O'Reilly Media	1/e, 2012

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.youtube.com/playlist?list=PL1F076D1A98071E24
2	https://www.youtube.com/playlist?list=PL1F076D1A98071E24
3	https://www.youtube.com/playlist?list=PL1F076D1A98071E24
4	https://www.youtube.com/playlist?list=PL1F076D1A98071E24 https://www.youtube.com/playlist?list=PLwdnzlV3ogoVsma5GmBSsgJM6gHv1QoAo

SEMESTER S6

EMBEDDED SYSTEM DESIGN

Course Code	**PEAET695**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	5/3	**Exam Hours**	2 Hrs.30 Min.
Prerequisites (if any)	PBECT404 Microcontrollers	**Course Type**	Theory

Course Objectives:

1. To introduce the building blocks of Embedded System and various Embedded Development strategies
2. To impart knowledge of RTOS and processor scheduling algorithms

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Embedded Systems** Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.	**8**
2	**Typical Embedded System** Core of the Embedded System – General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS). Memory – ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface – Onboard and External Communication Interfaces.	**10**
3	**RTOS Based Embedded System Design** Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multi processing and Multi-tasking, Task Scheduling, Task Communication – Shared Memory, Message Passing, Device Drivers, How to Choose an RTOS.	**9**
4	**Embedded system development process** Requirements, Architecture, Selection of Operating system, Processor Selection, Development platform, Programming language - Coding issues, Code optimization, Efficient input/output-Testing and debugging, Verify the software on the host system, Verify the software on the embedded system	**9**

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Internal Ex	Evaluate	Analyse	Total
5	15	10	10	40

Criteria for Evaluation(Evaluate and Analyse): 20 marks

- The students should design a complete embedded system which has real life application and is socially relevant.
- Select any ARM Cortex M processor, 16 bit Microcontroller or higher configuration devices.
- The project can be done as design and simulation or complete hardware implementation
- The project needs to be done as an individual project.

At the completion of the project, the students should be familiar with the following:

- Select an appropriate processor/Microcontroller for designing an embedded system
- Design an embedded system with limited resources
- Program the microcontroller/ARM Cortex M processor
- Interface various sensors/actuators/modules to the embedded system
- Parameters to be considered while developing the system for industrial purposes.

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. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• 2 questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. • Each question carries 9 marks. **(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	Understand fundamental embedded systems design paradigms, architectures, possibilities and challenges	**K2**
CO2	Analyze the sub systems of an embedded system and their interaction in the functionality of the embedded systems	**K2**
CO3	Practically apply gained theoretical knowledge to develop embedded systems.	**K3**
CO4	Apply formal techniques of simulation, testing, verification and validation in designing reliable and safe embedded 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	2	3		3							3
CO2	3		3		3							3
CO3	3	2	3		3							3
CO4	3		3		3	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	Introduction to Embedded Systems	Shibu K. V	Tata McGraw Hill	2nd Edition, 2017
2	Embedded System Design – A unified hardware/software Introduction	Frank Vahid, Tony Givargis	John Wiley	2006
3	Embedded Systems-Architecture, Programming and Design	Raj Kamal	Tata McGraw Hill	3rd Edition, 2017
4	Embedded Systems: An Integrated Approach	Lyla B. Das	Pearson	1st Edition, 2012

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Embedded System Design	Steve Heath	Elsevier/ Newnes	2nd Edition, 2002
2	Embedded Microcontrollers and Processor Design	Greg Osborn	Pearson	2011
3	Embedded Microcomputer Systems – Real Time Interfacing	Jonathan W. Valvano	Cengage Learning	2nd Edition, 2011

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/108102045
2	https://nptel.ac.in/courses/108102045
3	https://nptel.ac.in/courses/108102045 https://archive.nptel.ac.in/courses/106/105/106105172/
4	https://nptel.ac.in/courses/108102045 https://archive.nptel.ac.in/courses/106/105/106105172/

SEMESTER S6

LOGIC AND DISTRIBUTED CONTROL SYSTEM

Course Code	PBAET604	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)	Nil	Course Type	Theory

Course Objectives:

1. To design logic control systems for industrial applications.
2. To design PLC based control systems using ladder programming.
3. To describe distributed control system (DCS) and its components.
4. To explain networking protocols at different levels in hierarchical control

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Programmable Logic Controllers – power supplies and isolators. Program and Data organization in PLC – Input and Output modules, Discrete AC/DC, Analog Input/Output, Modular PLC. PLC programming Methods – IEC 61131-3 standard, Ladder programming. Basic PLC with Load and Store operations, PLC with Conditional Instructions.	9
2	General PLC programming procedures, programming on-off inputs/ outputs, auxiliary commands and functions, PLC basic Functions, register basics, timer functions, counter functions, Arithmetic functions, comparison functions, Skip and MCR functions, data move systems. PLC Advanced intermediate functions - Utilizing digital bits sequencer functions, Basic ladder diagram examples.	9
3	Distributed control system (DCS) - Introduction, DCS configuration with associated accessories, analog control, direct digital control, control console equipment, control unit (Relay Rack mounted equipment), local control	9

	units, attributes of DCS and DCS Flow sheet symbols. DCS System Integration I/O hardware stations, Set-point station control, Engineering interface and operator interfaces in DCS.	
4	Computers in process control - Direct Digital Control (DDC). Centralized control, Hierarchical control, Supervisory Control and Data Acquisition Systems (SCADA). Standard communication protocols for Instrumentation - Introduction, Advantages and limitations of HART Protocol, FIELDBUS and PROFIBUS. Industrial applications of PLC, SCADA, DCS and open systems for following plants - Thermal power plant and Steel Plant.	**9**

Note: It is mandatory that a ***course project*** should be done by the students in a group of maximum 4 members. The project can be in any of the following areas.

1. A typical application level wired Logic control system using combinational and/or sequential logic circuit. The entire logic control system (Both the system to be controlled and the designed logic controller) need to be implemented in hardware.
2. A typical application level logic control system with PLC as the controller. The entire logic control system (Both the system to be controlled and the PLC with ladder program) need to be implemented in hardware.

The course project should have interim evaluations and final evaluation which also includes a presentation and demonstration.

Steps involved in PBL:

- Selection of relevant topic.
- Selecting the system (mechanical/electrical/hydraulic/pneumatic) to be controlled.
- Selecting proper sensors.
- Designing the logic controller with digital circuits or using a PLC with Ladder programming.
- Hardware implementation of the logic control system by integrating the system, sensors and the controller developed.

Sample project ideas:

- Bottle filling system control
- Sensor based Traffic light controller
- Robotic arm/manipulator control
- Coffee wending machine

- Renewable power generation management
- Coin counter

Upon successful completion of the project, the student is expected to attain skills to design and make medium complexity logic control systems using combinational and/or sequential logic circuits and also using Programmable Logic Controllers (PLC) with ladder programming.

Evaluation parameters:

- Relevance of the topic
- Hardware Implementation
- Presentation skills

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. • Total of 8 Questions, each carrying 2 marks **(8x2 =16 marks)**	• 2 questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 2 sub divisions. • Each question carries 6 marks. **(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	Design and implement logic control systems for industrial applications	**K6**
CO2	Design and implement PLC based control systems using ladder programming	**K6**
CO3	Describe distributed control system (DCS) and its components	**K2**
CO4	Explain networking protocols at different levels in hierarchical control	**K2**

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	3	3		3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	2	2	2								3
CO4	3	2	2	2								3

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Programmable Logic Controllers	W. Bolton	Elsevier	4th Edition 2006
2	Distributed computer control for Industrial Automation	Popovic and Bhatkar	MareeetDekkar, N.York	1990
3	Computer based Industrial Control	Krishna Kant	Prentice Hall, New Delhi	2010
4	Distributed Control Systems	Michael P Lukcas	Van Nostrand Reinhold Co., New York	1986

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Programmable Logic Controllers - Principles and Applications	John.W.Webb, Ronald A Reis	Prentice Hall	5th Edition, 2002
2	Programmable Logic Controllers	Frank D. Petruzella	McGraw Hill, New York	2nd Edition, 2019
3	Elements of Process Control Applications	Deshpande P.B and Ash R.H	ISA Press, New York	1981
4	Computer Aided Process Control	Singh	Prentice Hall	2004
5	Programmable logic devices and logic controllers	Enrique Mandado, Jorge Marcos, Serafín A. Pérez	Prentice Hall	1996
6	Process Control Instrumentation Technology	Curtis D. Johnson	Pearson	8th Edition, 2005

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-me04/
2	https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-me04/
3	https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-me04/
4	https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-me04/

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 S6

DESIGN THINKING AND PRODUCT DEVELOPMENT

(Common to Group A & Group B)

Course Code	**GXEST605**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	2:0:0:0	**ESE Marks**	60
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To guide students through the iterative stages of design thinking, including empathizing with users, defining problems, ideating solutions and developing Proof of Concepts (PoC) and technical feasibility studies.
2. To promote the development of critical thinking skills by engaging students in integrative inquiry, where they ask meaningful questions that connect classroom knowledge with real-world applications.
3. To equip students with the ability to involve in product design considering the sustainability, inclusivity, diversity and equity aspects.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Fundamentals of design thinking and product development:** Overview of stages of product development lifecycle; Design thinking -Definition-Design thinking for product innovation; Bringing social impact in ideation-Identifying societal needs-understanding multi-faceted issues-community engagement and empathetic design- technological innovation meeting societal needs; Understanding and Bridging the divide using Human Centered Design (HCD); Designing for inclusivity in product development-embracing user diversity - Long term impact - sustainability encompassing environmental,economic and social dimensions; Technology Readiness Level in the Innovation Life-cycle; Performing a self-check on innovative	**6**

	ideas - Originality of idea- understanding innovation landscape - patentability - understanding the economic landscape - Unique Selling Proposition (USP) - Repeatability and Manufacturability - Sustainability - Leveraging business models for comprehensive analysis	
2	**Empathize:** Design thinking phases; Role of empathy in design thinking; Methods of empathize phase - Ask 5 Why/ 5 W+H questions; Empathy maps - Things to be done prior to empathy mapping - Activities during and after the session; Understanding empathy tools - Customer Journey Map - Personas. **Define**: Methods of Define Phase: Storytelling, Critical items diagrams, Define success.	**6**
3	**Ideation** : Stages of ideation; Techniques and tools - Divergent thinking tools - Convergent thinking tools - Idea capturing tools; Cross-industry inspiration; Role of research in ideation - Market research - consumer research - leveraging research for informed ideation; Technological trends - navigating the technological landscape - Integrating emerging technologies; Feasibility studies - technical, economic, market, operational, legal, and ethical feasibility; Ideation session- techniques and tips. **Proof of Concept (PoC) :** Setting objectives; Risk assessment; Technology scouting; Document and process management; Change management; Knowledge Capture; Validating PoC; Story telling in PoC presentation	**6**
4	**Design:** Navigating from PoC to detailed design; Developing Specification Requirement Document (SRD)/Software Requirement Specification (SRS); Design for manufacturability; Industrial standards and readability of code; Design to cost; Pre-compliance; Optimized code; Design Failure Mode and Effects Analysis (DFMEA); Forecasting future design changes. **Prototyping:** Alpha prototypes; Beta prototypes; Transition from design to prototype; Goals and expectations for Alpha and Beta prototypes; Effective strategies for maintaining timeline in prototyping; Testing and refining Alpha prototypes; Transitioning to Beta prototypes. **Pilot build:** Definition and purpose of a pilot build; setting objectives; Identification and selection of manufacturing partner for pilot build; Testing procedures in pilot build; Scaling from pilot build to full-scale production / implementation.	**6**

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignments	Internal Examination	Reflective Journal and Portfolio	Total
5	20	10	5	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. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(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	Empathize to capture the user needs and define the objectives with due consideration of various aspects including inclusivity, diversity and equity	**K5**
CO2	Ideate using divergent and convergent thinking to arrive at innovative ideas keeping in mind the sustainability, inclusivity, diversity and equity aspects.	**K6**
CO3	Engage in Human Centric Design of innovative products meeting the specifications	**K5**
CO4	Develop Proof of Concepts (PoC), prototypes & pilot build of products and test their performance with respect to the Specification Requirement Document.	**K4**
CO5	Reflect on professional and personal growth through the learnings in the course, identifying areas for further development	**K4**

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	2		2	3	3	3	2	2		3
CO2	3	2	3		2	3	3	3	2	2		3
CO3	3	2	3		2	3	3	2	2	2		3
CO4	3	2	2		3	3	3	2	2	2		3
CO5	3					3	3	2	2	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	Product Sense: Engineering your ideas into reality	Dr. K R Suresh Nair	NotionPress.com	2024
2	Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation	Tim Brown	HarperCollins Publishers Ltd.	2009
3	Design Thinking for Strategic Innovation	Idris Mootee	John Wiley & Sons Inc.	2013

Sample Assignments:

1. Evaluate and prepare a report on how the aspects including inclusivity, diversity and equity are taken into consideration during the empathize and define phases of the Miniproject course.
2. Evaluate and prepare a report on how the aspects including sustainability, inclusivity, diversity and equity are taken into consideration during the ideate phase of the Miniproject course.
3. Evaluate and prepare a report on how User-Centric Design (UCD) is used in the design and development of PoC of the product being developed in the Miniproject course.
4. Prepare a plan for the prototype building of the product being developed in the Miniproject course.
5. Report on the activities during the empathize phase including the maps & other materials created during the sessions.
6. Report on the activities during the define phase including the maps & other materials created during the sessions.
7. Report of all the ideas created during the ideation phase of the Miniproject course through the tools including SCAMPER technique, SWOT analysis, Decision matrix analysis, six thinking hats exercise
8. Prepare a full scale production plan for the product being developed in the Miniproject course.
9. Create a Stanford Business Model Canvas related to the Miniproject.

   An industrial visit of at least a day for experiential learning and submit a report on the learnings, for example industry standards and procedures.

SEMESTER S6

TRANSDUCERS AND MEASUREMENTS

Course Code	OEAET611	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)	NIL	Course Type	Theory

Course Objectives:

1. To familiarize the basics of Instrumentation system and its quality parameters.
2. To understand and apply the concepts of various transducers and other measuring instruments.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basics of Measurement- Generalized block diagram of Instrumentation system, Standards, Calibration of meters, Static and Dynamic characteristics of transducers, Errors in measurements and its analysis. Measurement of resistance, capacitance and inductance: DC and AC bridges, Sources and detectors- Balance Equation, Wheatstone Bridge, Maxwell's inductance bridge and Schering bridge	9
2	Transducers - Classification of transducers, Factors influencing choice of transducer. Passive transducers: Principle of operation, Construction details, characteristics, types and applications of Resistance transducers: Potentiometer, Strain gauge, RTD, Thermistor. Inductive Transducer: LVDT. Capacitive transducers: Variable air gap-Variable Area-Variable permittivity.	9
3	Active transducers- Principle of operation, Construction details, Characteristics, types and applications of Thermocouple, Piezo electric transducer, Hall effect transducer, Photovoltaic Cell. Opto-electric Transducers- Photodiode, Phototransistor, LDR Accelerometers: Piezoelectric, potentiometric, LVDT accelerometer.	9

	Non-Contact type transducers- Infrared-Ultrasonic proximity sensors, Optical level sensor-Ultrasonic level sensor, Radiation pyrometer.	
4	Measuring, Display, Analysing and Recording Instruments- Working and Torque equations of PMMC, PMMI, Electrodynamometer. Digital Storage oscilloscope, LCD displays, Spectrum Analyzer, Peak response voltmeter, True RMS meter, Strip chart recorder, XY Plotter.	**9**

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. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(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 basic concepts and performance characteristics involved in a measurement system.	**K2**
CO2	Explain the principle and working of various transducers, measuring, display, analysing & recording instruments	**K2**
CO3	Identify the bridge circuits that can be used for measuring unknown values of passive devices.	**K3**
CO4	Select different transducers according to the required field of application.	**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
CO3	3	3			3							3
CO4	3	3			3	3	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	Electronic Instrumentation and Measurements	David A Bell	Oxford	3rd Edition, 2017
2	Sensors and Transducers	D. Patranabis	PHI learning Pvt Ltd	2nd Edition, 2003
3	Electrical Measurements and Measuring systems	Golding E W and Widdis F C	Wheeler &co	1993
4	A Course in Electronic Measurements and Instrumentation	A K Shwany	Dhanpath Rai & Co	2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electronic Instrument Design	Kim R Fowler	Oxford reprint	2015
2	Principles of measurement system	John Bentley	Pearson	4th Edition
3	Electronic Instrumentation and Measurements	Kalsi HS	Mc Graw hill	4th edition, 2019
4	Transducers & Instrumentation	D V S Murty	PHI learning Pvt Ltd	2nd Edition, 2008
5	Introduction to Transducers	Arun K Ghosh	PHI learning Pvt Ltd	4th edition, 2014

Video Links (NPTEL, SWAYAM…)	
	Link ID
NPTEL VIDEO: Sensors & Actuators	https://archive.nptel.ac.in/courses/108/108/108108147/

SEMESTER S6

BIOMEDICAL ENGINEERING

Course Code	OEAET612	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)	NIL	Course Type	Theory

Course Objectives:

1. To familiarize biomedical engineering and its applications.
2. To understand the physiology of major systems of the body for designing biomedical devices.
3. To impart knowledge about various biomedical devices.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to biomedical instrumentation system, overview of physiological systems - heart, lungs and muscles. Sources of bioelectric potential - Resting and action potential, propagation of action potentials. Bioelectric potentials (introduction only) - ECG, EEG, EMG, ERG, EOG and EGG. Electrode theory - Nernst relation. Bio potential electrodes - microelectrodes, skin surface electrodes and needle electrodes.	9
2	Overview of electro conduction system of the heart. Electrocardiography - ECG lead configurations, ECG recording system, Einthoven triangle, analysis of ECG signals. Measurement of blood pressure - Direct, indirect and relative methods, auscullatory method, oscillometric and ultrasonic non-invasive pressure measurement. Measurement of blood flow - Electromagnetic and ultrasonic blood flow meters.	9

3	Overview of the human nervous system, action potential of brain, brain waves, types of electrodes, placement of electrodes, evoked potential, EEG recording and analysis of EEG. Electromyography - Nerve conduction velocity, instrumentation system for EMG measurement. Overview of the physiology of respiratory system, Respiratory parameters, spirometer, body plethysmographs, gas exchange and distribution.	**9**
4	Therapeutic Equipments (Principle, block schematic diagram, working and applications) - Pacemakers, cardiac defibrillators, heart–lung machine, dialyzers, surgical diathermy equipment and ventilators. Medical Imaging systems (Basic Principle only) - X-ray imaging, properties and production of X-rays, computed tomography, Magnetic resonance imaging system and nuclear medicine system. Ultrasonic imaging system - introduction and basic principle. Colour doppler systems.	**9**

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. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(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	Describe the need and applications of biomedical instrumentation	**K2**
CO2	Understand the physiology of major systems of the body for designing biomedical devices.	**K3**
CO3	Illustrate the principle of patient monitoring and therapeutic systems	**K2**
CO4	Explain the principle of medical imaging techniques	**K2**

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	2	3	3		3				3
CO2	3		3	2		3		3				3
CO3	3		3	2	3	3		3				3
CO4	3		3	2	3	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	Handbook of Biomedical Instrumentation	Khandpur R.S	McGraw-Hill	3rd Edition, 2014
2	Medical Instrumentation: Application and Design	John G. Webster, Amit J. Nimunkar	WILEY	5th Edition, 2020
3	Biomedical Instrumentation And Measurements	Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer	Pearson Education India	2nd Edition, 2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Biomedical Instrumentation: The technology of the patient care	Barbara L. Christe	Cambridge University Press	2nd Edition, 2017
2	Introduction to Biomedical equipment Technology	Joseph J.carr and John M. Brown	Wiley and Sons	4th Edition, 2000
3	Principle of Biomedical Instrumentation and Measurement	Richard Aston	Merrill Education/Prentice Hall.	1st Edition, 1990

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/108/105/108105101/
2	https://archive.nptel.ac.in/courses/108/105/108105101/ https://archive.nptel.ac.in/courses/102/105/102105090/
3	https://archive.nptel.ac.in/courses/108/105/108105101/ https://archive.nptel.ac.in/courses/102/105/102105090/
4	https://archive.nptel.ac.in/courses/102/105/102105090/

SEMESTER S6

MICROCONTROLLERS

Course Code	OEAET613	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)	-	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. The 8051 Microcontroller - 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 and Addressing modes - Classification of instruction set - Data transfer group, arithmetic group, logical group, branching group. Addressing modes - Types. Accessing the data from internal and external memory.	8
3	Programming 8051 Using Assembly Language - Introduction to 8051 assembly language programming. Data types and directives, Concept of subroutine. Software delay programming. 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. Serial Communication in 8051 - Serial communication – modes and protocols, RS-232 pin configuration and connection. Serial port programming – transmitting and receiving. Programming the interrupts - Use external, timer and serial port interrupts. Interrupt priority settings.	10

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. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(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	Outline the architecture of a 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 (Mapping of Course Outcomes to Program Outcomes)

	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

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	The 8051 Microcontroller and Embedded Systems Using Assembly and C	Muhammad Ali Mazidi Janice Gillispie Mazidi Rolin D. McKinlay	Printice 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…)	
	Link ID
NPTEL course I	Microprocessors and Microcontrollers - https://nptel.ac.in/courses/106108100
NPTEL course II	Microcontrollers and Applications - https://nptel.ac.in/courses/117104072

SEMESTER S6

POWER ELECTRONICS LAB

Course Code	**PCAEL607**	**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)	PCAET503 Power Electronics	**Course Type**	Lab

Course Objectives:

1. To design and implement various power electronic circuits

Expt. No.	Experiments
Part A – Bread board/PCB (Minimum of 6 Experiments)	
1	Power BJT drive circuits
2	Power MOSFET drive circuits
3	Snubber circuits
4	Three phase diode bridge rectifier
5	Single phase Controlled rectifiers with R and RL loads
6	Realization of basic Buck, Boost and Buck-Boost converters
7	Application of PWM IC TL 494
8	DC to AC inverter using MOSFET & IC
9	Realization of simple SMPS
Part B – Should be done using SPICE/MATLAB/TINA-TI (Minimum of 6 Experiments)	
10	Drive circuits for Power BJT
11	Drive circuits for Power MOSFET
12	Snubber circuits – shunt and series
13	Three phase diode bridge rectifier
14	Single phase Controlled rectifiers with R and RL loads
15	Realization of Buck, Boost and Buck-Boost converters
16	Realization of Isolated Converters - Push-Pull, Half bridge and Full bridge configurations
17	DC to AC inverter using MOSFET

18	Realization of simple SMPS
19	DC motor speed control

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 demonstrate the functions of Power electronic circuits	**K3**
CO2	Design and simulate the functioning of power electronic circuits using simulation tools	**K3**
CO3	Function effectively as an individual and in a team to accomplish the given task	**K3**

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	3					3	3	2		3
CO2	3	3	3		3			3	3	2		3
CO3	2	2	2					3	3	2		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	Power Electronics (An Indian Adaptation): Converters, Applications and Design	Ned Mohan, Tore M. Undeland and William P. Robbins	Wiley	3rd Edition, 2022
2	Power Electronics: Devices, Circuits, and Applications	M H Rashid	Pearson Education	4th Edition, 2017

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.