IN301N INDUSTRIAL AUTOMATION

Teaching Scheme : 03 L + 01 T; Total: 04 hours/week **Credits** : 04
Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This course provides an overall exposure to the technology of Industrial Automation as widely seen in factories of all types both for discrete and continuous manufacturing.

DESIRABLE AWARENESS / SKILLS

Digital electronics, Industrial instrumentation and Control system

COURSE OUTCOMES

On the successful completion of this course, students will be able to -

1. Identify the different components of an automation system.
2. Describe the hierarchical structure of industrial automation systems
3. Understand the concept of proportional, integral and derivative control.
4. Develop a ladder diagram from the narrative event sequence description.
5. Contrast quick opening, linear and equal percentage control valves in terms of flow versus stem position.
6. Identify different auxiliary components used in industrial automation.

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs

(WITH STRENGTH OF CO-RELATION)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	-	-	-	-	-	1	2	-
CO2	2	3	2	1	2	1	-	-	-	1	-	3	1	-
CO3	3	2	2	1	3	1	-	1	-	-	1	2	2	1
CO4	2	2	1	1	1	-	-	-	1	-	-	2	2	1
CO5	3	2	2	1	-	2	-	-	-	2	2	3	2	1
CO6		2			1								2	

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Introduction: Role of automation in industry, dynamic manufacturing environment, categories of production systems, differences between automation control and supervisory control, the structural elements of industrial control, industrial actuator systems, continuous variables and discrete event control, supervisory control, production control. **[8 Hrs.]**

Control System Components: Different components of hydraulic, pneumatic and electronic systems, 2-wire transmitters, differential pressure transmitters, temperature, electro-hydraulic transmitters, pneumatic to electric converter, electrical to pneumatic converter, square root extractor. **[8 Hrs.]**

Controller Principles: Process characteristics, process equation, process load, process lag, self regulation, control system parameter, error, variable range, control parameter range, control lag, dead time, cycling, controller modes, two position mode, multi-position mode, floating control mode, proportional control mode, integral control mode, derivative control mode, PI, PD, PID, its tuning, implementation of control modes in pneumatic, hydraulic, and electronics. **[8 Hrs.]**

Sequence control, PLC: Introduction, sequence control example, Programmable Logic Controller, architecture, basic components, add-on components, program scan and memory organization, relay ladder, timers and counters. **[6 Hrs.]**

Flow Control Valves: Terminology, types and characteristics, selection of control valves, concept of Cv, calculation of Cv and trim size, cavitations and flashing, noise in control valves, testing of control valve, valve positioners, necessity, types and effect on performance of control valves, electrical, pneumatic and hydraulic actuators, electro-pneumatic and electro-hydraulic actuators. **[6 Hrs.]**

Auxiliary Components: Synchro, servo motor, stepper motor, feeders and dampers, intrinsic safety and components, gyroscope, indicators and alarm annunciator, control panels **[4 Hrs.]**

Reference books:

1. Industrial Instrumentation, Control and Automation, S. Mukhopadhyay, S. Sen and A. K. Deb, Jaico Publishing House, 2013
2. Chemical Process Control, An Introduction to Theory and Practice, George Stephanopoulos, Prentice Hall India, 2012
3. Webb and Reis, ―Programmable Logic Controllers: Principles and Applications‖, PHI, 2009.
4. S. Haykin, Neural Networks: A Comprehensive Foundation, Prentice- Hall India, 2nd Edition, 1999.
5. Process Control and Instrument Technology by C.D.Jhonson, eighth edition, Prentice-Hall of India 2006.
6. Handbook of Instrumentation Engineers (Process Control) Vol.1. by Bela G.Liptak, Fifth Edition.

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

IN302N MICROCONTROLLER AND APPLICATIONS

Teaching Scheme : 03 L + 00 T; Total: 03 hours/week **Credits** : 03
Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

It is an introductory course on microcontrollers with coverage of architecture, hardware interfaces, peripherals, software programming and description of applications. This subject will provide stimulating learning experience while facilitating students to become proficient in designing with 8051. It impart knowledge about the complete hardware of the microcontrollers and software used to develop programs.

DESIRABLE AWARENESS / SKILLS

Digital Design, Digital Logic, Number system in digital system. Analog Electronics, Programming in C language,

COURSE OUTCOMES

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

1. Draw and describe architecture of 8051 and peripherals
2. Write assembly language program for microcontrollers
3. Demonstrate programming skills on embedded C
4. Interface various peripheral devices to the microcontrollers
5. Design microcontroller-based system for various applications

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs

(WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	2	2	-	-	-	-	-	-	-	-	1	2	-	-
2	3	3	3	3	3	-	-	2	-	-	-	3	-	2
3	2	3	3	3	3	-	-	-	-	-	2	3	1	2
4	3	3	3	2	2	--	-	-	-	1	-	3	2	2
5	3	2	2	3	1	1	1	-	-	-	-	3	2	3

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Introduction to Microcontroller

Overview of Microprocessors and Microcontrollers and difference between them, Introduction to Embedded Systems. Microcontroller families and selection criteria, Microcontroller Architectures (Harvard vs. Von Neumann), RISC vs. CISC Architectures, Overview of Microcontroller Families Evolution and applications in Various Fields. Advanced microcontrollers like Raspberry pi, STM 32, etc. **[6 Hrs.]**

8051 Microcontroller Architecture

8051 Microcontroller Architecture, Pin Configuration and Functions, I/O Ports, Clock and Reset Circuit, Memory Organization (RAM, ROM, Registers, SFRs), Instruction Set and Addressing Modes, Assembly Language Programming Basics, Instruction timings. **[6 Hrs.]**

8051 Programming

8051 Instruction Set (Data Transfer, Arithmetic, Logical, Branching), Writing and Executing Assembly Language Programs (ALP), Debugging and Simulation Tools (Keil uVision, Proteus), Developing, Building, and Debugging ALP's, Concept of assembler directives, editor, linker, debugger, simulator, and emulator. Looping and time delay calculations, Introduction to embedded-C, software development tools for 8051, integrated development environment, assembler, simulator and compiler. **[8 Hrs.]**

8051 Parallel I/O Ports

Input / Output Port concepts, structure, and operation, Programming (Reading and Writing to Ports), LED and Push Button Interfacing, External memory Interface: Data and Program memory interface and programing, Seven-Segment Display (SSD) Interfacing, LCD (16x2) Interfacing, Interfacing of Analog-to-Digital Converter (ADC) and Digital-to-Analog Converter (DAC) using parallel ports. Keypad Matrix Interfacing. **[6 Hrs.]**

8051 Interrupts, Timers/Counters and Serial Communication

8051 Interrupt System, External and Internal Interrupts, Programming Interrupts and writing Interrupt Service Routines (ISR), Understanding Timers and Counters in 8051, Timer Modes, programming, and Applications, Basics of Serial Communication (RS232, UART), Serial modes, programming, and Applications, Interfacing 8255A with 8051**.** **[6 Hrs.]**

Interfacing other devices

Stepper motor and DC motor interface, Sensor Interfacing (Temperature, Ultrasonic, IR, etc.), Home Automation System using 8051, Adding Wi-Fi and Bluetooth capability to the Microcontroller. Other recent microcontrollers and their applications in process industry, Overview of Advanced Microcontrollers (PIC, AVR, ARM), Comparison of 8051, PIC, AVR, and ARM Microcontrollers. Basic features of RFID, ZIGBEE, GSM/GPS, USB, MMC & SD, Ethernet MAC and their interface with microcontroller **[8 Hrs.]**

Text Books:

1. 8051 Microcontroller Hardware, Software and Applications by V. Udayashankara and M. S. Mallikarjunaswamy, Tata McGraw Hill, 2009.
2. The 8051 Microcontroller and Embedded Systems Using Assembly and C by Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinlay, second edition, Pearson Education, 2006.

Reference Books:

1. 8051 Microcontroller: Internals, Instructions, Programming and Interfacing by Subrata Ghoshal, second edition, Pearson Education, 2010.
2. 8051 Microcontroller by Sampath K. Venkatesh, published by S. K. Kataria and Sons, 2014.
3. Intel Manual: MCS-51 Architecture.
4. http://www.keil.com
5. NTPL, MOOC courses on this topic.

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

EE303N: SIGNALS AND SYSTEMS

Teaching Scheme	**:** 03 L + 00 T; Total: 03 hours/week	**Credits**	**:** 03
Evaluation Scheme	**:** 10 ISA + 30 MSE + 60 ESE	**Total Marks**	**:** 100
ESE Duration	**:** 3 Hrs.		

COURSE DESCRIPTION

Signals and Systems is an introduction to analog and digital signal processing, a topic that forms an integral part of engineering systems in many diverse areas, including seismic data processing, communications, speech processing, image processing, defense electronics, consumer electronics, and consumer products

COURSE OUTCOMES:

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

1. Understand about various types of signals, classify them, analyze them, and perform various operations on them.
2. Understand about various types of systems, classify them, analyze them and understand their response behavior.
3. Appreciate use of transforms in analysis of signals and system.
4. Carry simulation on signals and systems for observing effects of applying various properties and operations.
5. Classify random signals using statistical concepts and characterize systems using pseudo-random signals

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	1	2					1			1				
2		1		1	2		1		2			2	2	
3	1	2				1			2					
4	1			2		1							2	
5	1		2				2			2	2	2		

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Classification of Signals and Systems:

Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids_ Classification of signals — Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals — Classification of systems- CT systems and DT systems- — Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable. **[8 Hrs.]**

Analysis of Continuous Time Signals:

Fourier series for periodic signals — Fourier Transform — properties- Laplace Transforms and properties **[7 Hrs.]**

Linear Time Invariant Continuous Time Systems:

Pulse response — convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems — Systems connected in series / parallel. **[8 Hrs.]**

Analysis of Discrete Time Signals:

Baseband signal Sampling — Fourier Transform of discrete time signals (DTFT) — Properties of DTFT — Z Transform & Properties. **[8 Hrs.]**

Linear Time Invariant-Discrete Time Systems:

Impulse response — Difference equations-Convolution sum- Discrete Fourier Transformand Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel. **[8 Hrs.]**

Text Books

1. Gabel R.A. and Robert R.A., Signals and Linear Systems, John Wiley and Sons, 3 rd Edition, 2009
2. Oppenheim A.V., Wilsky and Nawab, Signals and Systems, Prentice Hall, 2nd Edition, 1997.
3. Chen C.T., Systems and Signal Analysis - A Fresh Look, Create Space, 3 rd Edition, 2011

Reference Books

1Cooper G.R and Mc Gillem C.D, Probabilistic Methods of Signals and System Analysis, Oxford University Press, 3 rd Edition, 1999.
2. Chesmond, Wilson and Lepla, Advanced Control System Technology, Viva Books, 1 st Edition, 1998.
3. Ziemer R.E., Tranter W.H., and Fannin D.R., Signals and Systems: Continuous and Discrete, Prentice Hall, 4 th Edition, 1998.

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

IN304NA: POWER PLANT INSTRUMENTATION

Teaching Scheme : 03 L + 00 T; Total: 03 hours/week **Credits** : 03
Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

The course focuses on different types of power plants. The necessity of power plant automation, different process and their Instrumentation requirements. Study of various standards and state of art technologies used in power sector.

COURSE OUTCOMES

Upon successful completion of this course the students will be able to:

1. Understand of Instrumentation used in power plant.
2. Learn various types of renewable and non renewable sources of power generation.
3. Ability to demonstrate the standards used in power plants.
4. Understand the impact of power plant operation in environmental and societal context.

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	3	2	2	2	3	2	2	3	1		1	2	1	2
2	2	1	1		2	2	2	3		1		1	1	1
3	2	1	3	2	3	2	2	2			1	3	1	2
4	2	2	2	2	1	2	2	3	1	1	1	2	2	2

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Introduction to Power Plant: Power plant terminologies and key terms, power plant classification: thermal, hydro, nuclear, co- generation, comparison of various power plants based on technology, usage, efficiency, and limitations. **[8 Hrs.]**

Boiler Ancillaries Various ancillaries used in steam generation units, viz. water treatment, electro-static precipitator, soot blower, economizer, de-aerator, super heater, chemical dosing systems, air pre-heater, coal and ash handling systems, fuel storage and distribution, bag house filters. **[8 Hrs.]**

Boiler Control Types of boilers, various control such as: combustion control, air to fuel ratio control, 3-element drum level control, steam temperature and pressure control, O2/CO2 in flue gases, furnace draft, boiler interlocks, sequence event recorder, supervisory control, data acquisition controls, burner management systems and controllers, start-up and shut-down procedures, boiler safety standards, boiler inspection procedures. **[8 Hrs.]**

Turbine Instrumentation Turbine Instrumentation Turbine instrumentation and control, start-up and shut-down, thermal stress control, turbine supervisory instrumentation, condition monitoring, generator, power distribution instrumentation. **[6 Hrs.]**

Nuclear Power Plant Instrumentation: Classification of nuclear reactors, nuclear reactor control loops, fuel cycle, control and safety instrumentation, reliability aspects and various modes of operations. **[6 Hrs.]**

Non-conventional energy sources and Power Distribution Schemes: Wind power, solar power, tidal power, diesel generator controls, substation automation and smart grid, energy harvesting. **[4 Hrs.]**

Text Books:

1. Sam. G. Dukelow, ―The Control of Boilers, ISA Press, New York, 2nd ed., 1991.
2. David Lindsley, ―Boiler Control Systems, McGraw Hill, New York, 1st ed., 1991

Reference Books:

1. Manoj Kumar Gupta, ―Power Plant Engineering, PHI Learning Private Limited, 1st ed., 2012.
2. G.S. Sawhney, ―Non-Conventional Energy Resources, PHI Learning Private Limited, 1st ed., 2012
3. Gill A.B, ―Power Plant Performance, Butterworth, London, 1st ed., 1984.

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

IN304NB: VIRTUAL INSTRUMENTATION

Teaching Scheme : 03 L + 00 T; Total: 03 hours/week **Credits** : 03
Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This course gives opportunity to learn basics of Graphical and Dataflow programming. Understanding of NI LabVIEW Software. Use various tools in software for developing Virtual instruments. Study of different hardware for interfacing real data signal to LabVIEW. Designing of applications for real time systems in biomedical signal acquisition and processing, Measurement and control of physical and chemical parameters, Industrial automation system development.

DESIRABLE AWARENESS / SKILLS

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COURSE OUTCOMES

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

1. Understand the concept of Virtual Instrumentation and how it differs from traditional hardware-based instrumentation
2. Learn to use LabVIEW (or other software platforms) for designing virtual instruments
3. Understand the principles of data acquisition and how to interface hardware with computers using DAQ systems
4. Learn techniques for processing and analyzing signals within a virtual instrument environment

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	3	2	1	1	2	1	-	-	-	-	-	2	2	-
2	2	2	1	1	2	1	-	-	1	-	1	3	1	-
3	2	1	2	1	1	1	-	-	-	2	-	2	1	1
4	2	1	1	1	1	-	-	2	-	-	-	2	1	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Virtual Instrumentation **[10 Hrs.]**

Review of Virtual Instrumentation (VI), Historical perspective, Need of VI, Advantages of VI, Define VI, block diagram and architecture of VI, data flow techniques, graphical programming in data flow, comparison with conventional programming.

Graphical Programming using LabVIEW **[10 Hrs.]**

Programming Techniques, VIS & Sub VIS, loops & charts, arrays, clusters, graphs, case & sequence structures, formula nodes, local and global variable, string, file handling, states machines etc.

Hardware Convertor Circuits And Digital to analog converters: **[10 Hrs.]**

Weighted resistor/converter, binary ladder, converter, accuracy and resolution; Analog to digital converter: quantization and encoding, different types of conversion, accuracy and resolution

Data Acquisition basics, ADC, DAC, DIO, Counters & timers, PC Hardware structure, timing, interrupts, DMA, Software and Hardware Installation.

Common Instrument Interfaces for Current loop, Rs 232C/Rs 485, GPIB, System basics, interface basics: USB, PCMCIA, VXI, SCXI, PXI VISA & IVI, hardware for signal and image acquisition and processing. NI ELVIS board. NI virtual bench.

Applications **[10 Hrs.]**

Use of various hardware tools like DAQ cards, ELVIS board, Virtual bench for design of VI: Application in process control equipment's design, Oscilloscope, Digital Millimeter using Lab view Software, use of VI for data acquisition and control using Lab VIEW for physical parameters like temperature, pressure, flow, level etc. design of automation systems, design real time systems for signal and image acquisition and processing using LabVIEW.

Text Books

1. Johnson, G., LabVIEW Graphical Programming, McGraw−Hill (2006). 2. Sokoloft, L., Basic Concepts of LabVIEW 4, Prentice Hall Inc. (2004). 3. Wells, L.K. and Travis, J., LabVIEW for Everyone, Prentice Hall Inc. (1996).
2. Let Us LabVIEW by Nitesh Pradhan

Reference Books

1. Basic Concepts of Labview by Sokoloff, Prentice Hall, New Jercy, 1998.
2. PC interfacing for Data Acquisition & process control by S. Gupta, J.P.Gupta, second Edition, Instrument Society of America, 1994.
3. M. Morris Mano, Michael D. Ciletti, "Digital Design", Pearson, 2013.
4. A. K. Maini, "Digital Electronics: Principles, Devices And Applications, Wiley, 2007.

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

IN304NC: POWER ELECTRONICS

Teaching Scheme : 03 L + 00 T; Total: 03 hours/week **Credits** : 03
Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

The course aims learning of basic principles of power electronics. It comprises of the basic concepts, components and various circuits in power electronics. The students can use this knowledge to understand, design and implement various power electronics circuits for industrial applications.

COURSE OUTCOMES

On the successful completion of this course, students will be able to -

1. Apply basic knowledge of power family components for designing power control circuits.
2. Understand the working principles, classifications of various power electronics circuits.
3. Analyze the characteristics, controls, power stages and applications of power electronic circuits.
4. Design and implement industrial applications of power electronic circuits.

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs
(WITH STRENGTH OF CO-RELATION)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	-	-	-	-	-	1	2	1
CO2	2	3	2	1	2	1	-	2	1	1	2	3	1	-
CO3	3	2	2	1	3	1	-	1	-	1	-	2	2	1
CO4	2	2	1	1	1	-	-	-	3	2	1	2	2	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Power Family Components SCR:

SCR construction and characteristics and working of SCR, Triac, Diac, SCS, SUS, LASCR, methods of turning on an SCR, turn-on, turn-off mechanism and characteristic, device specifications, rating and nomenclature of SCR, SCR triggering circuits, R, RC, pulse and UJT triggering circuits, Protection circuits for SCR, multiple connection of SCR: series operation, parallel operation, string efficiency. Commutation of SCR: Natural and Forced commutation techniques. **[8 Hrs.]**

Rectifier and Inverter:

Controlled rectifier: Single phase and three-phase controlled rectifier circuits, with R, RL load, with FWD, dual converters.

Inverters: Principle of operation of series inverter, parallel inverter and bridge inverter, designing of commutating component, UPS and SMPS. **[8 Hrs.]**

AC voltage controllers and Cycloconverters:

AC voltage controllers: single-phase & three-phase with R and RL load.

Cycloconverter: single-phase and three-phase cycloconverters, induction heating and dielectric heating, resistance welding. **[8 Hrs.]**

Chopper and Speed Control of Motor Choppers:

Classification of choppers, step-up, step-down chopper, Jones chopper, Morgan chopper, and principle of operation for each method. Chopper control techniques, Speed control of single- phase induction motor-using SCR and triac: various methods their circuit diagrams and working. **[8 Hrs.]**

Industrial Applications SCR control applications:

AC and DC static circuit breaker, over voltage protection circuit, zero voltage switch, Integral-cycle triggering, time delay circuit, soft start circuit, temperature regulator, SCR-controlled dimmer circuit, emergency light using SCR, automatic water level indicator, automatic battery charger using SCR, ultrasonic's and applications. **[8 Hrs.]**

Text Books:

1. Power Electronics by Dr. P. S. Bimbhra, Fourth Edition, Khanna Publisher.
2. Power Electronics by P. C. Sen, Tata McGraw Hill.

Reference books:

1. An Introduction to Thyristors and Their Applications by M. Ramamoorthy, second edition, East-West Press, 1991.
2. Power Electronics by M. D. Singh and K. B. Khanchandani, second edition, Tata McGraw Hill, 2007.
3. Industrial Electronics and Control by S. K. Bhattacharya, S. Chatterjee, Tata McGraw Hill.

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

IN305NX: BASICS OF PROCESS INSTRUMENTATION

Teaching Scheme : 02L + 00 T; **Credits** : 02
Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This course introduces the terminology, concepts, and practices of process modeling and automatic process control. It provides an overview of process control design. The course covers process characteristics, multi-loop control, different process control loop analyses, and tuning of PID controllers for various processes, along with their responses to changes in load and set point.

COURSE OUTCOMES

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

1. Estimate the input variables, output variables, constraints and characteristics of processes and determine control objectives.
2. Derive, develop a mathematical model using fundamental laws and by performing experiments on prototype systems.
3. Design a PID controller using direct synthesis and IMC strategy for stable processes (either minimum or non-minimum phase). Tuning of PID controller using open loop process reaction curve method and closed loop ultimate cycle method.
4. Design Cascade, Ratio, Feed forward, Selective, Split range and Inferential Control. Understand physical realization limitations due to time delays and RHP zeros.
5. Determine the degree of interaction and proper input-output pairings that best suited for the control problem through the concept of relative gain array (RGA), and design a de-coupler controller

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	3											2	2	1
2	3	2										2	2	1
3	3	2	3									3	3	1
4	3	3			3	2						3	3	1
5	3	3	2	1	1	2						1	2	1

1-Weakly correlated **2 – Moderately correlated** **3 – Strongly correlated**

COURSE CONTENT

Introduction to Process Control **[7 Hrs.]**

Introduction to process control, objectives and benefits, Characteristics of processes, design aspects of process control, regulatory and servo control, classification of variables. Process lag, degrees of freedom, Types of processes, Dead time, self- Regulating /non-self-regulating, single and multi-capacity, interacting and non-interacting, Linear/nonlinear processes, and selection of control action for them , inverse response, load disturbance and their effect on processes

Process Models for Control **[7 Hrs.]**

Necessity of process modeling, Mathematical modeling of simple processes like Surge tank level and stirred tank reactor. Development of empirical model using Step inputs, Approximation of higher order models, Dynamic behavior of first order and second order systems, Pole- Zero effect on process response.

Feedback Controllers **[7 Hrs.]**

Block Diagram, Elements of the feedback Loop, Response to Set- point changes, ON-OFF controller, P, I, D, PI & PID Controller Algorithms, Tuning of Controller, Controller Performance measures.

Advanced Control Techniques **[7 Hrs.]**

Basic principles of cascade control, feed forward control, feedback, feed-forward, Ratio control, selective control, Split range control and Inferential Control. Concept of Multi loop Control, Interactions and its effects, block representation and transfer function matrix of two input two output systems, pairing of controlled and manipulated variables-Relative Gain Array, Decoupler and decoupler design.

Text Books

1. Chemical Process Control: An Introduction to Theory and Practice, G. Stephanopoulos, Prentice Hall of India, New Delhi, 2001
2. Process Instrumentation Technology, Curtis D. Johnson, Seventh Edition Prentice Hall of India, New Delhi, 2005.

Reference Books

1. Process Control Systems, Application, Design and Tuning , F.G. Shinskey, Fourth Edition, McGraw Hill. 1996
2. Process Systems Analysis, and Control, D.R. Coughanowr, McGraw Hill, Singapore, Third Edition, 2009.
3. Process Control: Designing Processes and Control Systems for Dynamic Performance, T. E. Marlin, McGraw Hill, International Edition, 2000.
4. Process Control Modeling, Design and Simulation, B.W. Bequette, Prentice Hall of India, New Delhi, 2004.

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

IN305NY: VIRTUAL INSTRUMENTATION

Teaching Scheme : 02 L + 00 T; Total: 02 hours/week **Credits** : 02
Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This course gives opportunity to learn basics of Graphical and Dataflow programming. Understanding of NI LabVIEW Software. Use various tools in software for developing Virtual instruments. Study of different hardware for interfacing real data signal to LabVIEW. Designing of applications for real time systems in biomedical signal acquisition and processing, Measurement and control of physical and chemical parameters, Industrial automation system development.

DESIRABLE AWARENESS / SKILLS

-

COURSE OUTCOMES

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

1. Understand the concept of Virtual Instrumentation and how it differs from traditional hardware-based instrumentation
2. Learn to use LabVIEW (or other software platforms) for designing virtual instruments
3. Understand the principles of data acquisition and how to interface hardware with computers using DAQ systems
4. Learn techniques for processing and analyzing signals within a virtual instrument environment

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	3	2	1	1	2	1	-	-	-	-	-	2	2	-
2	2	2	1	1	2	1	-	-	-	-	-	3	1	-
3	2	1	2	1	1	1	-	-	-	-	-	2	1	1
4	2	1	1	1	1	-	-	-	-	-	-	2	1	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Virtual Instrumentation **[7 Hrs.]**

Review of Virtual Instrumentation (VI), Historical perspective, Need of VI, Advantages of VI, Define VI, block diagram and architecture of VI, data flow techniques, graphical programming in data flow, comparison with conventional programming.

Graphical Programming using LabVIEW **[7 Hrs.]**

Programming Techniques, VIS & Sub VIS, loops & charts, arrays, clusters, graphs, case & sequence structures, formula nodes, local and global variable, string, file handling, states machines etc.

Hardware Convertor Circuits And Digital to analog converters: **[7 Hrs.]**

Weighted resistor/converter, binary ladder, converter, accuracy and resolution; Analog to digital converter: quantization and encoding, different types of conversion, accuracy and resolution

Data Acquisition basics, ADC, DAC, DIO, Counters & timers, PC Hardware structure, timing, interrupts, DMA, Software and Hardware Installation.

Common Instrument Interfaces for Current loop, Rs 232C/Rs 485, GPIB, System basics, interface basics: USB, PCMCIA, VXI, SCXI, PXI VISA & IVI, hardware for signal and image acquisition and processing. NI ELVIS board. NI virtual bench.

Applications **[7 Hrs.]**

Use of various hardware tools like DAQ cards, ELVIS board, Virtual bench for design of VI: Application in process control equipment's design, Oscilloscope, Digital Millimeter using Lab view Software, use of VI for data acquisition and control using Lab VIEW for physical parameters like temperature, pressure, flow, level etc. design of automation systems, design real time systems for signal and image acquisition and processing using LabVIEW.

Text Books

1. Johnson, G., LabVIEW Graphical Programming, McGraw−Hill (2006). 2. Sokoloft, L., Basic Concepts of LabVIEW 4, Prentice Hall Inc. (2004). 3. Wells, L.K. and Travis, J., LabVIEW for Everyone, Prentice Hall Inc. (1996).
2. Let Us LabVIEW by Nitesh Pradhan

Reference Books

1. Basic Concepts of Labview by Sokoloff, Prentice Hall, New Jercy, 1998.
2. PC interfacing for Data Acquisition & process control by S. Gupta, J.P.Gupta, second Edition, Instrument Society of America, 1994.
3. M. Morris Mano, Michael D. Ciletti, "Digital Design", Pearson, 2013.
4. A. K. Maini, "Digital Electronics: Principles, Devices And Applications, Wiley, 2007.

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

IN307N: INDUSTRIALL AUTOMATION LAB

Teaching Scheme : Practical 02; Total: 02 hours/week **Credits:** 01
Evaluation Scheme : 30 ICA + 20ESE **Total Marks** : 50
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This lab course provides the knowledge of various control components and controllers used for Industrial automation. It gives hands-on practice to differential pressure transmitter, Current to Pressure and Pressure to Current converters. Flow characteristics of control valves and the analysis of of various control modes like P, PI, PID. Thorough study of the course will develop skill and competency to control various process and systems.

Minimum Ten experiments shall be performed to cover entire curriculum of course IN301N INDUSTRIAL AUTOMATION. The list given below is just a guideline.

List of Experiment:

1. To plot the characteristics of I/P or P/I converter.
2. Calibration of DP transmitter for flow/ level interface.
3. To plot the characteristics of control valve.
4. PLC programming using Relay ladder Logic for AND, OR, XOR and NOR gate.
5. PLC timer, counter and analog input/output functions
6. To study the basic of automation, structures of instrumentation system and safety consideration
7. Study of synchro transmitter and receiver
8. Study the characteristics of stepper motor
9. Study of hydraulic actuators.
10. Study of pneumatic actuators
11. Analysis of industrial process using Proportional, Integral mode.
12. Analysis of industrial process using Proportional-Integral and Proportional-Derivative mode.
13. Temperature control using PID controller
14. Level control using PID controller
15. Flow control using PID controller
16. Pressure control using PID controller
17. Tuning of PID controller

Note:

● **ICA –** Internal Continuous Assessment shall support for regular performance of practical and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on practical performed by him/her. The performance shall be assessed experiment wise using internal continuous assessment format. **(S 10).**

● **ESE –** The End Semester Examination (ESE) for this laboratory course shall be based on performance in one of the experiments performed by student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners out of which one examiner shall be out of institute.

IN308N: MICROCONTROLLER AND APPLICATIONS LAB

Teaching Scheme : Practical 02; Total: 02 hours/week **Credits:** 01
Evaluation Scheme : 30 ICA + 20 ESE **Total Marks** : 50
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This course covers various aspects of 8051C and embedded assembly and C language programming and interfacing. A Microcontroller Lab is a practical learning environment where students and professionals explore the design, programming, and interfacing of microcontrollers. This course provides hands-on experience in working with embedded systems, peripherals, sensors, actuators, and communication protocols..

DESIRABLE AWARENESS / SKILLS

Digital Design, Digital Logic, Number system in digital system. Analog Electronics, Programming in C language,

COURSE OUTCOMES

On the successful completion of this course, students will be able to

1. Identify and describe architecture of 8051 and peripherals
2. Write assembly language program for microcontrollers
3. Demonstrate programming skills on embedded C
4. Interface various peripheral devices to the microcontrollers
5. Design microcontroller-based system for various applications

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	1	-	1	-	-	-	-	-	1	2	1	-
CO2	3	3	3	3	3	-	2	-	1	2	-	2	-	2
CO3	2	3	3	3	3	-	1	-	-	-	-	3	1	2
CO4	3	3	3	2	2	1	-	2	-	1	1	3	2	2
CO5	3	2	2	3	1	1	1	-	-	-	-	3	2	3

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Minimum Ten experiments (3Assembly, 3 C program, 4 interfacing) shall be performed to cover entire curriculum of course IN302U. The list given below is just a guideline.

LIST OF EXPERIMENT:

1. Introduction to Microcontroller 8051 Instruction set.
2. Write a 8051 assembly language program for multiplication / division of two 8-bit numbers.
3. Write a 8051 ALP to find smallest / largest number from a given array.
4. Write a 8051 ALP to find number from a given array.
5. Write a 8051 ALP to transfer the block of memory contents from one to another memory location in same/ reverse direction.
6. Write a 8051 ALP to arrange the numbers in ascending/ descending order.
7. Write a 8051 ALP to add/subtract two numbers and display on LCD display.
8. Introduction to software development tools: SC51 compiler.
9. Write a C program to turn on the buzzer/glow LED through 8051 I/O ports.
10. Introduction to software development tools: Micro-vision C compiler and simulator.
12. Write a C program to send a message on serial port and simulate the same in Micro-vision C compiler and simulator.
13. Write a C program to turn on the port LEDs based on key input from port pushbuttons.
14. Write a C program for communication between PC and 8051 μc through serial port.
15. Write a program to generate two square waves – one of 5 KHz frequency at pin P1.3 and another of frequency 25 KHz at pin P2.3. Assume XTAL=22 MHz.
16. Write a 8051 C program to send letters to LCD using delays.
17. Write a Program to control the speed of DC motor.
18. Write a program to control the speed of stepper motor.
19. Other interfacing programs, as available in lab.
20. mini project on home automation or process control

Note:

• **ICA –** Internal Continuous Assessment shall support for regular performance of practical and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on practical performed by him/her. The performance shall be assessed experiment wise using internal continuous assessment format (S 10).

• **ESE –** The End Semester Examination (ESE) for this laboratory course shall be based on performance in one of the experiments performed by student in the semester followed by questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners out of which one examiner shall be out of institute.

IN310NA POWER PLANT INSTRUMENTATION LAB

Teaching Scheme : Practical 02; Total: 02 hours/week **Credits:** 01
Evaluation Scheme : 30 ICA + 20 ESE **Total Marks** : 50
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

Instrumentation play important role in power plants where instrumentation used as controlling and monitoring of various operation. The course explores the overview of different power plants and knowledge of different measuring instrument and monitoring instruments are used in power plants. The type and measuring methods changes with respect of type of power plants. The course provides the knowledge of different of instruments use for electrical, Thermal and hydraulic system.

COURSE OUTCOMES

On the successful completion of this course, students will be able to
1. Understanding of Instrumentation used in power plant.
2. Ability to demonstrate the standards used in power plants.
3. Understanding the impact of power plant operation in environmental and societal context.
4. Design instrumentation and controls in power plant.

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	-	-	-	-	-	-	-	-	-	2	-	-
CO2	3	3	3	3	3	-	-	-	-	-	-	3	-	2
CO3	2	3	3	3	3	-	-	-	-	-	-	3	1	2
CO4	3	3	3	2	2	--	-	-	-	-	-	3	2	2

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Minimum Ten experiments shall be performed to cover entire curriculum of course IN304NA. The list given below is just a guideline.

Note: Visit to power plant is expected and the report on the same should be submitted as a part of Laboratory work.

LIST OF EXPERIMENT:

1. Instrumentation for Hydro-electric/thermal power plant.
2. Instrumentations for safety in Nuclear power plants.
3. Solar power analyzer for solar power plants.
4. Wind flow meter for wind power plants.
5. Design and development of interlocks and safety system for thermal power plants.
6. Selection of instrumentation system for thermal power plant.
7. Design of boiler automation using DCS and PLC.
8. Boiler safety instrumentation.
9. Turbine control system.
10. Regional/National power grid.
11. Case study of Non-Conventional Energy scenario in India.

Note:

• **ICA –** Internal Continuous Assessment shall support for regular performance of practical and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on practical performed by him/her. The performance shall be assessed experiment wise using internal continuous assessment format (S 10).

• **ESE –** The End Semester Examination (ESE) for this laboratory course shall be based on performance in one of the experiments performed by student in the semester followed by questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners out of which one examiner shall be out of institute.

IN310NB: VIRTUAL INSTRUMENTATION LAB

Teaching Scheme : Practical 02; Total: 02 hours/week **Credits:** 01
Evaluation Scheme : 30 ICA + 20 ESE **Total Marks** : 50
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

In this laboratory, course emphasis on imparting the hands on, practical knowledge and understanding of basics of graphical and dataflow programming methods, learning of NI LabVIEW software, use of various tools in software for developing a VI, study of different hardware available in laboratory for interfacing real data signal to LabVIEW, design real time systems for measurement and control and biomedical signal processing.

COURSE OUTCOMES

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

1. 1. use of various tools in software for developing a VI and interfacing different hardware.
2. identify salient traits of a virtual instrument and incorporate these traits in their Projects.
3. experiment, analyze and document in the laboratory prototype measurement Systems using a computer, plug-in DAQ interfaces and bench level instrument.

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	2	2	-	-	-	-	-	-	-	-	-	2	-	-
2	3	3	3	3	3	-	-	-	-	-	-	3	-	2
3	2	3	3	3	3	-	-	-	-	-	-	3	1	2

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Minimum **ten** experiments from the list of experiments provided below shall be performed to cover entire curriculum of course IN304NB.

List of Experiments:

1. To study programming for virtual instrument using LabVIEW.
2. Develop a LabVIEW program for conversion of
   - degree celsius to fahrenheit
   - degree celsius to kelvin
   - degree celsius to rankin
3. Implementation of full adder using LabVIEW.
4. To generate 'n' random number using for loop and plot it.
5. To develop a LabView program for creating function generator for variable with variable amplitude, frequency and phase.
6. To Develop a LabView program for addition of
   - Array with Array
   - Array with Number
   - Cluster with Number
7. Develop a LabVIEW program for addition of matrix with matrix and waveform with number.
8. Develop a LabView program for demonstration using case structure and sequence structure.
9. Develop a LabVIEW program for Amplitude, Phase and Frequency measurement.
10. To Integrate and use Hardware compatible with LabVIEW like DAQ Cards, NI ELVIS board.
11. Develop a LabVIEW based temperature measurement and control System.
12. Demonstrate five integrated virtual instruments using NI Virtual bench.
13. Demonstrate of 12 integrated virtual instrument using NI ELVIS2.
14. Analog and Digital I/O handling using NI DAQ6009.
15. Demonstrate of NI ELVIS2 based Mechatronics sensor board

Evaluation Methodology:

- **ICA –** It shall support for regular performance of practical and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on practical performed by him/her. The performance shall be assessed experiment wise using the prescribed internal continuous assessment format.
- **ESE –** It shall be based on performance in one of the experiments performed by student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners, out of which one examiner shall be external examiner.

IN310NC: POWER ELECTRONICS LAB

Teaching Scheme : Practical 02; Total: 02 hours/week **Credits:** 01
Evaluation Scheme : 30 ICA + 20ESE **Total Marks** : 50
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

In this laboratory, course emphasis on imparting the practical knowledge and understanding of basic principles, characteristic, performance of power family components and power electronics circuits. It also gives the platform for designing and implementing industrial applications of power control circuits for industrial drives and control.

Minimum Ten experiments shall be performed to cover entire curriculum of course IN304NC POWER ELECTRONICS. The list given below is just a guideline.

List of Experiment:

Teacher should facilitate learning following lab experiments:

1. Design and plot the characteristics of SCR.
2. Design and plot the characteristics of triac.
3. Design and implement different firing circuit for thyristor.
4. Design and implement single-phase half wave controlled rectifier.
5. Design and implement single-phase full wave controlled rectifier.
6. Design and implement different commutation circuits.
7. Design and implement series inverter.
8. Design and implement parallel inverter.
9. Design and implement single phase cycloconverter.
10. Design and implement step-up chopper.
11. Design and implement step-down chopper.
12. Design and implement SCR controlled dimmer circuit.
13. Design and implement AC/DC universal motor speed control using SCR.
14. Design and implement AC/DC Universal motor speed control using triac.

Note:

● **ICA –** Internal Continuous Assessment shall support for regular performance of practical and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on practical performed by him/her. The performance shall be assessed experiment wise using internal continuous assessment format.

● **ESE –** The End Semester Examination (ESE) for this laboratory course shall be based on performance in one of the experiments performed by student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners out of which one examiner shall be out of institute.

IN311N: COTROL SYSTEM FOR ELECTRICALVEHICLE

Teaching Scheme: 03 L + 00 T; Total: 03 hours/week **Credits:** 03
Evaluation Scheme: 10 ISA + 30 MSE + 60 ESE **Total Marks:** 100
ESE Duration : 3 Hrs.

COURSEDESCRIPTION

This course provides a comprehensive understanding of control systems as applied to electric vehicles (EVs). Students will explore the principles and techniques used to design, analyze, and implement control systems for various subsystems within an EV.

DESIRABLEAWARENESS/SKILLS

Fundamental knowledge of control systems and electrical engineering principles

COURSEOUTCOMES

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

1. Understand the requirement of EV in future uses.
2. Acquire the knowledge of control technique in EV.
3. Analyze the concept of electrical drives use in EV design.
4. Apply the control techniques in EV design.

RELEVANCE OF COURSE OUTCOMES (COS) WITH POS AND PSOS (WITHSTRENGTHOFCO-RELATION)

CO	PO											PSO		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
1	1		1			1	3					2	2	
2	2			1		2	3					2	2	
3	2	2		1		1	2					2	2	
4	2	2	1	1	2	2	2					2	2	

1-Weaklycorrelated 2 – Moderately correlated 3–Stronglycorrelated

COURSE CONTENT

Introduction to Electric vehicles:

Present scenario of electric vehicles, Need of Electric Vehicles, Economic and environmental impacts of using Electrical vehicles. Challenges faced by electric vehicles to replace ICE. Major requirements of electric vehicles. **[7 Hrs.]**

Electric Drives Concepts

Choice of electric drives, advantages, nature and classification of drives, control and stability of electric drives, feedback control of drives. DC DRIVES: - Transient analysis of separately excited dc motors, Closed loop control of solid-state DC drives. **[7 Hrs.]**

Model based control approach for Electric Vehicle:

Introduction to P, PI & PID Controller, and Internal Model Control (IMC) Design, Introduction to Model based control system design for Electric Vehicle. **[7 Hrs.]**

Vehicle Dynamics and Stability Control

Basics of vehicle dynamics and control, Traction control systems, Anti-lock braking systems (ABS), Stability control systems **[7 Hrs.]**

Autonomous Driving Systems

Sensors and perception systems, Path planning and motion control, Integration of autonomous driving technologies in EVs **[6 Hrs.]**

Applications

Applications of control techniques in Traction control, Vehicle Control, Electric power steering control. **[6 Hrs.]**

Text Books:

1. Modeling and Control: A Mechatronic Approach", JohnWiley &Sons Ltd, 2014.
2. Katsuhiko Ogata, Modern Control Engineering ,PHI, Twelfth Edition

References:

1. AntoniSzumanowski,"HybridElectricPowerTrainEngineeringandTechnolog y: Modeling, Control, and Simulation", IGI Global, 2013.
2. R.T.Stefani,B.Shahian,C.J.Savant,Jr.,andG.H.Hostetter,DesignofFeedbackControl Systems, Oxford University Press, Fourth Edition
3. Rajesh Rajamani, Vehicle Dynamics and Control ,Springer, Second Edition
4. WuweiChen,HansongXiao,QidongWang,LinfengZhaoandMaofeiZhu,Integrate d Vehicle Dynamics and Control, Wiley, First Edition

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

IN312N: CONTROL SYSTEM FOR ELECTRICAL VEHICLE LAB

Teaching Scheme : Practical 02; Total: 02 hours/week **Credits:** 01
Evaluation Scheme : 30 ICA + 20 ESE **Total Marks** : 50
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This course consists of minimum 8 experiments based on theory syllabus of **IN312N**. Experiments should involve simulation/performance/design of practical, result and conclusion based on it. The sample list given below is just a guide line.

DESIRABLE AWARENESS / SKILLS

IN312N: CONTROL SYSTEM FOR ELECTRICAL VEHICLE

COURSE OUTCOMES

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

1. Understand the basic concept of electric vehicles and power electronics converter devices.
2. Develop practical skills in designing, programming, and testing control systems for electrical vehicle.
3. Analyze the various controllers used in DC and AC drives.
4. Create awareness among students about the concepts of electric vehicle system engineering.

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	2	1	1	2	2	2	2	2	2		1	2	2	**2**
2	2	2	2	2			3	2	1			2	2	**2**
3	2	1		2		1	2	2	2	1	1	2	1	**2**
4	2	1	1	1	1	2		2	2	2	1	1	2	**1**

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Minimum **eight** experiments from the list of experiments provided below shall be performed to cover entire curriculum of course IN312N

List of Experiments:

1. Cost-benefit analysis of EV adoption versus ICE vehicles.
2. Life Cycle Assessment (LCA) of EVs compared to ICE vehicles.
3. Impact of battery recycling processes on reducing environmental hazards.
4. Demonstrate the differences between AC and DC drives through practical testing.
5. Study the effect of load torque and speed variation on different types of electric drives.
6. Analyze the stability of an electric drive system using root locus or Bode plot methods.
7. Compare the performance of an electric drive under open-loop and closed-loop conditions.
8. Implement a PID controller to regulate the speed of a DC motor.
9. Develop and test a model-based speed control system for a BLDC motor using MATLAB/Simulink.
10. Simulate and implement regenerative braking control for an EV drive system.
11. Compare the performance of PID and IMC in rejecting external disturbances for an EV motor.
12. Study the effect of braking force distribution between front and rear wheels on vehicle stability.
13. Evaluate overall system performance in terms of accuracy, response time, and robustness
14. Analyze the energy efficiency of autonomous driving technologies in EVs.

Evaluation Methodology:

- **ICA –** It shall support for regular performance of practical and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on practical performed by him/her. The performance shall be assessed experiment wise using the prescribed internal continuous assessment format.
- **ESE –** It shall be based on performance in one of the experiments performed by student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners, out of which one examiner shall be external examiner.

IN351N: PROCESS INSTRUMENTATION

Teaching Scheme : 03L + 00 T; **Credits** : 03
Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

To introduce terminology, concepts and practices of process modeling and automatic process control. It gives an overview of process control design. The course will cover process characteristics, Multi loop control, Different process control loop analysis, tuning of PID Controller for different process and their response to change in load and set point.

DESIRABLE AWARENESS / SKILLS

Basics of Transducers and Automatic Control

COURSE OUTCOMES

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

1. Estimate the input variables, output variables, constraints and characteristics of processes and determine control objectives.
2. Derive, develop a mathematical model using fundamental laws and by performing experiments on prototype systems.
3. Design a PID controller using direct synthesis and IMC strategy for stable processes (either minimum or non-minimum phase). Tuning of PID controller using open loop process reaction curve method and closed loop ultimate cycle method.
4. Design Cascade, Ratio, Feed forward, Selective, Split range and Inferential Control. Understand physical realization limitations due to time delays and RHP zeros.
5. Determine the degree of interaction and proper input-output pairings that best suited for the control problem through the concept of relative gain array (RGA), and design a de-coupler controller

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	3	2	1	1					1			2	2	1
2	3	2			1		1			1		2	2	1
3	3	2	3			3		2				3	3	1
4	3	3			3	2			1		2	3	3	1
5	3	3	2	1	1	2	2					1	2	1

1-Weakly correlated **2 – Moderately correlated** **3 – Strongly correlated**

Introduction to Process Control

Introduction to process control, objectives and benefits, Characteristics of processes, Design aspects of process control, regulatory and servo control, classification of variables, Process lag, degrees of freedom, Types of processes, Dead time, self- Regulating /non-self-regulating Single and multi-capacity, Interacting and non-interacting, Linear/nonlinear processes, and selection of control action for them, inverse response, load disturbance and their effect on processes. **[6 Hrs.]**

Process Models for Control

Necessity of process modeling, Mathematical modeling of simple processes like Surge tank level and stirred tank reactor. Development of empirical model using Step inputs, Approximation of higher order models, Dynamic behavior of first order and second order systems, Pole- Zero effect on process response. **[6 Hrs.]**

Feedback Controllers

Block Diagram, Elements of the feedback Loop, Response to Set- point changes, ON-OFF controller, P, I, D, PI & PID Controller Algorithms, Effect of tuning parameters, Response to Disturbances inputs, Stability Analysis, Process reaction curve and Ziegler Nichols closed loop tuning, Fine tuning of controllers, Control Performance Measures, Correlations for tuning Constants. **[6 Hrs.]**

Advanced Control Techniques

Basic principles, Design Criteria, Performance, Controller Algorithm and Tuning, Implementation issues of- Cascade control, feed forward control, feedback, feed-forward Ratio control, Selective Control, Split range control and Inferential Control. **[6 Hrs.]**

Multi loop Control

Concept of Multi loop Control, Interactions and its effects, block representation and transfer function matrix of two input two output systems, pairing of controlled and manipulated variables-Relative Gain Array, Singular Value Analysis and effect of Interaction on stability. Decoupler and decoupler design **[8 Hrs.]**

Model based Control

Model based controller-design procedure for direct synthesis method, tuning relations based on integral error criteria, Smith predictor, Internal Model control-design procedure for FOPDT, SOPDT and Inverse response processes, Effect of model uncertainty and disturbances, design of improved disturbance rejection, IMC based PID controller design procedure for delay free processes and Introduction to Model predictive control. **[8 Hrs.]**

Text Books

1. Chemical Process Control: An Introduction to Theory and Practice, G. Stephanopoulos, Prentice Hall of India, New Delhi, 2001
2. Process Instrumentation Technology, Curtis D. Johnson, Seventh Edition Prentice Hall of India, New Delhi, 2005.

Reference Books

1. Process Control Systems, Application, Design and Tuning, F.G. Shinskey, Fourth Edition, McGraw Hill. 1996
2. Process Systems Analysis, and Control, D.R. Coughanowr, McGraw Hill, Singapore, Third Edition, 2009.
3. Process Control: Designing Processes and Control Systems for Dynamic Performance, T. E. Marlin, McGraw Hill, International Edition, 2000.
4. Process Control Modeling, Design and Simulation, B.W. Bequette, Prentice Hall of India, New Delhi, 2004.

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

IN352N: DISTRIBUTED CONTROL SYSTEM

Teaching Scheme : 03 L + 00 T; Total: 03 hours/week **Credits** : 03
Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

A distributed control system (DCS) is a computerized control system for a process or plant usually with many control loops, in which autonomous controllers are distributed throughout the system, but there is no central operator supervisory control.

DESIRABLE AWARENESS / SKILLS

IN301N: Industrial Automation

COURSE OUTCOMES

On the successful completion of this course, students will be able to:
1. Understand the basic operation and selection criteria of PLC.
2. How to develop the programming by using PLC
3. Understand basic of DCS and automation tools.
4. Understand the basic of communication tool.
5. Apply the concepts of process control to the automation of processes

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	2	1			2				1		1	2	2	
2	2	1					1		1			2	2	
3	3	1	2	2	2				2	1		2	2	1
4	2	2	2	2						1	1	2	3	2
5	3	3	3	2	2	1		2			1	3	3	3

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Programmable Logic Controller **[8 Hrs.]**

Evolution of PLC, definition, functions, advantages, architecture, DI-DO-AI-AO examples and ratings, I/O module, working of PLC, scan time, types of PLC, choosing PLC for application, installation of PLC, rack installation, grounding and shielding, physical, electrical, maintenance requirements, planning, verifying, troubleshooting, fault diagnosis techniques, Need of interfacing, PLC interface to hydraulic/pneumatic circuits, programming devices and languages as per IEC 61131-3 like IL, ST, FBD, CFC, SFC, PLC timers and counters, PLC selection, installation and troubleshooting, advanced PLC instructions like program control, comparison, mathematical, logical, communication, shift registers, sequencers, data handling.

Ladder Diagram **[8 Hrs.]**

Background, ladder diagram elements, ladder diagram examples, programmable controllers, relay sequencer, programmable controller operation, programming, advanced features, ladder diagrams and programming for some examples of process control using PLC.

Distributed Control Systems (DCS) **[8 Hrs.]**

Introduction, difference between DCS and centralized computing system. Block diagram of DCS, data highways, multiplexers and remote sensing terminal units Study of various aspects of DCS like communication protocol, displays, cables etc., various system architectures of DCS.

Network protocols Tools **[8 Hrs.]**

HART protocol, frame structure, programming, implementation examples, advantages and limitations of field bus, FDS configuration, comparison with other field bus standards including device net, profibus, control net,industrial Ethernet, MAP and TOP.

Supervisory Control and Data Acquisition (SCADA) **[8Hrs.]**

Introduction to supervisory control and data acquisition (SCADA) as applied to process control systems: Introduction to various SCADA packages, study of RSVIEW32 (AB make package) development of mimics using RSVIEW32 SCADA package, Study of WinCC.

PLC, SCADA, DCS and open system for following plants: cement plant, thermal power plant, steel plant, glass manufacturing plant, paper and pulp plant.

Text Books

1. Process Control by Bela G. Liptak, Third edition, Chilton.1995
2. Programmable Logic Controller by J.D.Otter, first edition, (PHI), 1987.

Reference Books

1. Application of Computer in Process Control by Considine, Fifth Edition, Tata McGraw Hill.
2. Distributed Computer Control for Industrial Automation by Vijay P. Bhatkar, , Dekker, CRC Press .
3. Computer-based Industrial Controls by Krishan Kant, Second edition, PHI 2004.

ASSESMENT:

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ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

IN353N: UNIT OPERATIONS AND CONTROL

Teaching Scheme : 02 L + 00 T; Total: 02 hours/week **Credits** : 02
Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

The course is designed to familiarize the student with the unit operations and the instrumentation systems. This course contains the introduction of unit operations and its application to the present industry. The course contains basic principles of design of controllers for basic operations like evaporation, distillation etc.

COURSE OUTCOMES

On the successful completion of this course, students will be able to -

1. Understand block diagram of chemical process.
2. Understand classification of unit operation
3. Understand the process of distillation and other unit operation equipment.
4. Select suitable size reduction equipment, separation equipment and proper conveying medium.
5. Apply the concepts of process control to the automation of processes.

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs

(WITH STRENGTH OF CO-RELATION)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	-	-	-	-	1	1	2	-
CO2	2	3	2	1	2	1	-	-	-	2	-	3	1	-
CO3	3	2	2	1	3	1	-	1	-	-	2	2	2	1
CO4	2	2	1	1	1	-	-	-	-	-	-	2	2	1
CO5	3	2	2	1	-	-	-	-	-	3	1	3	2	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Unit operation and unit process concept: block diagram of chemical process, classification of unit operation, material and energy balance, batch and continuous process **[4 Hrs.]**

Distillation: Vapor- liquid equilibrium, equipment setup, Flash Distillation, Batch Distillation, Continuous Distillation, operational features, construction and working only. **[4 Hrs.]**

Evaporation: Liquid characteristics, types of evaporators, principle and operation of single and multiple effect evaporators. **[2 Hrs.]**

Drying: Classification of dryer, basic principle and operation, Types of dryers: tray drier, rotary drum drier, vacuum drier, fluidized bed drier, dryer control. **[2 Hrs.]**

Filtration: Mechanism of filtration, types of filters. **[2 Hrs.]**

Crystallization: Types of crystallizers, principle and operation. **[2 Hrs.]**

Size reduction: Size reduction and mechanical separation operations: Crushing and grinding, size separation and screening. Selection criteria and considerations for equipment used for size reduction and mechanical separation. **[4 Hrs.]**

Heat Exchangers: Basic modes of heat transfer, basic laws, Heat transfer equipments: double pipe heat exchanger, shell and tube heat exchanger: type of shell and tube exchanger, Temperature pattern in heat exchanger **[4 Hrs.]**

Unit operations in different industries: Identification and justification of unit operations used in different industries like food, paper, sugar, cement, fertilizer, Petrochemical industry with help of process flow diagram ` **[4 Hrs.]**

Text Books:

1. Warren L. McCabe, Julian C. Smith, Peter Harroitt "Unit Operation in Chemical Engineering" McGraw Hill. Fifth ed., 2005.
1. Instrumentation Engineers Handbook Vol II: Process Control and Optimization by Bela G. Liptak, 4th edition, CRC Press, 2006.
2.

Reference books:

1. Automatic Process Control by P. Harriot, Tata McGraw-Hill Publishing Company Limited.
2. Chemical Engineer's Handbook by Perry, 6^{th} edition, McGraw hill int. student Ed.
3. Elementary Principles of Chemical Processes by Fedler, Rotsseau, Herriot, Wiley, 1978.
4. Outline of Chemical Technology by Gopalrao, M. Sitting, 2nd edition, East West Press.

ASSESMENT:

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2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

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ESE: End Semester Exam will be based on 100% of the syllabus

IN355NA: DIGITAL SIGNAL PROCESSING

Teaching Scheme : 03 L + 00 T; Total: 03 hours/week **Credits** : 03
Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

Digital Signal Processing (DSP) is concerned with the representation, transformation and manipulation of signals on a computer. The course emphasizes understanding and implementations of theoretical concepts, methods and algorithms.

DESIRABLE AWARENESS / SKILLS

IN303N: signals and systems.

COURSE OUTCOMES

Student will be able to
1. Sample and reconstruct any analog signal
2. Find frequency response of LTI system
3. Find Fourier Transform of discrete signals
4. Design of IIR & FIR filter and implementation of them
5- Know basics of DSP processor.

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	1	2		1			1			1				
2	1		2		2	3		2	2		1	2	2	1
3	1	2						1	2		1	3		
4	1			2		1		1			1		2	
5	1		2				2			2		2		1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Introduction **[8 Hrs.]**

DSP Preliminaries, Sampling, DT signals, sampling theorem in time domain, sampling of analog signals, recovery of analog signals, and analytical treatment with examples, mapping between analog frequencies to digital frequency, representation of signals as vectors, concept of Basis function and orthogonality. Basic elements of DSP and its requirements, advantages of Digital over Analog signal processing.

Discrete Fourier Transform **[8 Hrs.]**

DTFT, Definition, Frequency domain sampling , DFT, Properties of DFT, circular convolution, linear convolution, Computation of linear convolution using circular convolution, FFT, decimation in time and decimation in frequency using Radix-2 FFT algorithm, Linear filtering using overlap add and overlap save method, Introduction to Discrete Cosine Transform. Revision to Z-transform and its properties.

IIR Filter Design **[8 Hrs.]**

Concept of analog filter design (required for digital filter design), Design of IIR filters from analog filters, IIR filter design by approximation of derivatives, , IIR filter design by impulse invariance method, Bilinear transformation method, warping effect. Characteristics of Butterworth filters, Chebyshev filters and elliptic filters, Butterworth filter design, IIR filter realization using direct form, cascade form and parallel form, Finite word length effect in IIR filter design

FIR Filter Design **[8 Hrs.]**

Ideal filter requirements, Gibbs phenomenon, windowing techniques, characteristics and comparison of different window functions, Design of linear phase FIR filter using windows and frequency sampling method. FIR filter realization using direct form, cascade form and lattice form, Finite word length effect in FIR filter design.

Filter Realization **[8 Hrs.]**

Structures for FIR filters, Structures for IIR filters, State-space analysis and filter structures, Fixed point and floating-point representation of numbers, Errors resulting from rounding and truncating, Quantization effects of filter coefficients, Round-off effects of digital filters.

Introduction to DSP Processor **[8 Hrs.]**

Sampling rate conversion by a non-integer factor, Design of two stage sampling rate converter, General Architecture of DSP, Case Study of TMS320C67XX, Introduction to Code composer studio. Application of DSP to Voice Processing, Music processing, Image processing and Radar processing.

Text Books

1. Chen, C.T., Digital Signal Processing: Spectral Computation & Filter Design, Oxford Univ. Press, 2001.
2. Proakis, J.G., Manolakis, D.G., Digital Signal Processing: Principles, Algorithms, & Applications, Prentice Hall of India, 3rd Edition, 2007.

3. Ifeachor, E.C., & Jervis, B.W., Digital Signal Processing: A Practical Approach, Pearson Education Asia, 2nd Edition, 2009.

Reference Books

1. Mitra, S.K., Digital Signal Processing: A Computer-Based Approach, McGraw Hill, NY, 4th Edition, 2011.
2. A.V. Oppenheim, R. W. Schafer, J. R. Buck, "Discrete Time Signal Processing", 2nd Edition Prentice Hall, ISBN 978-81-317-0492-9.
3. Li Tan, Jean Jiang, " Digital Signal Processing : Fundamentals and applications" Academic press

ASSESMENT:

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1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

EE355NB: MODERN CONTROL THEORY

Teaching Scheme	**:** 03 L + 00 T; Total: 03 hours/week	**Credits**	**:** 03
Evaluation Scheme	**:** 10 ISA + 30 MSE + 60 ESE	**Total Marks**	**:** 100
ESE Duration	**:** 3 Hrs.		

COURSE DESCRIPTION:

n this course, you will learn to recognize, model, formulate and solve optimal control problems that arise in a diverse range of applications including; circuits, mechanics, robotics, finance, etc

COURSE OUTCOMES:

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

1. Develop a mathematical model of physical system.
2. Analyze the issue related to the stability of control system.
3. Perform state variables analysis for any real time system.
4. Examine a system for its stability, controllability, and observability.
5. Implement basic principles and techniques in designing linear control systems

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	1	2					1			1				1
2		1		1	2		1		2			2	2	
3	1	2							2	1		1		
4	1			2		1			1				2	1
5	1		2				2			2	2	2		

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Mathematical background:
Matrices: Definition of Matrices; Matrix Algebra; Matrix Multiplication and Inversion; Rank of a Matrix; Differentiation and Integration of Matrices. **[6 Hrs.]**

State Variable Analysis:
Introduction, concepts of state, state variables and state model, state-space representation for linear continuous-time systems. Time domain solution of state equations: Solution of homogeneous state equations, state transition matrix, evaluation of matrix exponential (eAt), solution of non- homogeneous state equations. **[7 Hrs.]**

State space representation:
State-space representation of high order differential equations, state space representation of transfer function in controllable, observable and diagonal form, relationship between state equations and transfer function. Signal flow graph of state equations, decomposition of transfer function, diagonalization, eigen values and eigen vectors, modal matrix. **[7 Hrs.]**

Controllability and Observability:
Concept of Controllability and Observability; Controllability and Observability tests for continuous time system; Controllability and Observability of discrete time system; Controllability and Observability of state model in Jordan canonical form. **[6 Hrs.]**

Models of Digital control devices and systems:
Introduction to z-transform, ROC in z-transform, basic discrete time signals, time domain models of discrete time systems, transfer function models, stability on z-plane and jury stability criteria, z-domain description of sampled continuous time plants, z-domain description of systems with dead time, Implementation of digital controllers, Tunable PID controllers, Methods of tuning industrial PI, PID controllers. **[7 Hrs.]**

Nonlinear systems:
Introduction, common physical nonlinearities of saturation, dead-zone, relay, relay with dead zone, hysteresis, backlash. **[6 Hrs.]**

Text Books

1. Modern Control Engineering, Katsuhiko Ogata, Prentice Hall, 5th edition, 2010
2 Modern Control System Theory, M.Gopal,New Age International Publishers, Revised 2nd Edition,2005

Reference Books

1. Digital Control and Stable Variable Mehod, M. Gopal, TATA McGraw Hill Company
2. Discrete time control system Katsushiko Ogata, Prentice Hall Publication,©1995.
3. Modern control system M.Gopal, TATA McGraw Hill Company
4. Control System Engineering L.J.Nagrath and M.Gopal, New Age International Publication Fourth Edition 2006.

ASSESMENT:

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ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

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ESE: End Semester Exam will be based on 100% of the syllabus

IN355NC: INSTRUMENTATION SYSTEM DESIGN

Teaching Scheme : 03L + 00 T; **Credits** : 03
Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

The course provides an overview of static and dynamic performance characteristics of instruments. Selection criteria for flow, temperature, etc. transducers. Design considerations for transducers such as thermocouple, RTD, orifice plates, Rota meter. Calibration and installation procedure for different transducers. The subject also specifies noise free controller and control panel design techniques.

DESIRABLE AWARENESS / SKILLS

Basics of Transducers and Automatic Control

COURSE OUTCOMES

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

1. explain general transducer design considerations
2. design and implement signal conditioning circuits for different transducers.
3. apply various aspect of noise free design
4. design control panels and controllers
5. analyze and apply reliability concepts

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	3							2				2	2	1
2	3	2			1		1			1		2	2	1
3	3	2	3							1	2	3	3	1
4	3	3			3	2		1				3	3	1
5	3	3	2	1	1	2				1		1	2	1

1-Weakly correlated **2 – Moderately correlated** **1** **3 – Strongly correlated**

Basic Concepts of Transducer Design **[8 Hrs.]**

General transducer design consideration, testing of transducer, and selection criteria of transducer. Design of temperature measurement system based on RTD, thermocouple and thermistors, design of displacement measurement system using LVDT, Potentiometer, Ultrasonic transducer, complete signal conditioning circuits for above temperature and displacement transducers.

Design of Flow and Pressure Transducers **[8 Hrs.]**

design aspects of flow & Pressure transducers, design of orifice, rotameter and venturi tube based flow system and signal conditioning circuits for above system. Design of level sensors and its signal conditioning circuits, design of pressure gauge, diaphragm based pressure gauge, Load cell and its signal conditioning, study of P/I and I/P converters, design of smart transmitters.

Reliability **[8 Hrs.]**

Concept of reliability definition, distinction between Quality and reliability, failures, Availability, Maintainability, (MTBF, MTTF, MTTR) Life Cycle and Bathtub curve, Reliability Modeling Exponential, Weibull and Gamma Distribution, Hazard rate and Derivation of MTTF Failure Density Function, Cumulative Distribution Function and Reliability, availability, maintainability, quality assurance.

Noise free Design **[8 Hrs.]**

Guidelines for enclosure design, components and accessories, grounding and shielding techniques noise in electronic circuits, EMI/ EMC protection against EMI, ESD selection of cables, connectors, types of knobs, mechanical fixture PCB holders, clamps, control panel layout ergonomics, types of' gear boxes and drives. Ingress protection authorized regulatory bodies for certifying instruments in Hazardous location (BASEEFA, FM, PTB, UL, CESI, LLIE, CSA, DEMKO, and IEC & CENELEC).

Design of Control Panels and Controllers **[8 Hrs.]**

Control panel design considerations, types of control panel designs, ergonomics in design of control panel, control room layout, cabling, wiring details. Pneumatic controllers using flapper-nozzle mechanism, Electronics controller using op-amps, considerations in design of data presentation elements, recorders, and monitors

Text Books

1. A course in Electrical and Electronic Measurements and Instrumentation, A. K. Sawhney, 9th edition, Dhanpat Rai & co, 2011
2. Reliability, Bal Guruswamy E,Tata McGraw-Hill Pub.co. NewDelhi,1999.
3. Andrew Williams, Applied instrumentation in the process industries, 2nd Edition, Vol. 1 & 3, Gulf publishing company (1993)

Reference Books

1. Applications of Analog Integrated Circuit, S. Soclof, PHI.1985
2. Measurement Systems, Doeblin E. O. and D. Mannik, McGraw-Hill, 5th Edition,.
3. Instrument Engineer's Hand Book, Process Measurement Volume I and Process Control Volume II, Bela G. Liptak, Chilton Company, 3rd Edition, 2001.

4. Electrostatic Discharge and Electronic Equipment, A Practical Guide for Designing to Prevent ESD Problems, Warren Boxleitner, IEEE Press,1989

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

IN356NA NEURAL NETWORK AND FUZZY LOGIC

Teaching Scheme : 03 L + 00 T; Total: 03 hours/week **Credits** : 03
Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This syllabus provides an overview of the fundamental concepts, theories, and applications of Neural Networks and Fuzzy Logic in artificial intelligence, machine learning, and control systems.

DESIRABLE AWARENESS / SKILLS

Calculus, Linear Algebra, Statistics and Predominant Programming Language.
MATLAB/Python and C

COURSE OUTCOMES

On the successful completion of this course, students will be able to -

1. Explain the fundamental concepts of Artificial Neural Networks (ANN) and their biological inspiration.
2. Construct fuzzy sets, membership functions, and fuzzy rules.
3. Integrate Neural Networks with Fuzzy Logic for intelligent systems (Neuro-Fuzzy Systems).
4. Apply ANN and Fuzzy Logic in practical applications and a given real world problem.
5. Understand recent trends in AI, Deep Learning, and Neuro-Fuzzy models and develop problem-solving skills for real-world AI challenges.

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs

(WITH STRENGTH OF CO-RELATION)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	-	-	-	-	-	1	2	-
CO2	2	3	2	1	2	1	-	-	-	-	-	3	1	-
CO3	3	2	2	1	3	1	-	-	-	-	-	2	2	1
CO4	2	2	1	1	1	-	-	-	-	-	-	2	2	1
CO5	3	2	2	1	-	-	-	-	-	-	-	3	2	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Artificial Neural Networks: Structure and function of a single neuron, Architectures: motivation for the development of artificial natural networks. Artificial neuron models, Types of activation functions, Neural network architectures, Feedforward Neural Networks and Supervised Learning, Evaluation of networks, Supervised Learning I: Perceptron and LMS Supervised Learning II: Backpropagation and Beyond. **[10 Hrs.]**

Application of neural networks: for Classification−algorithm, Unsupervised learning, winner Clustering, Pattern associations, Function approximation, Forecasting. Neural Networks in Control Systems, Direct Adaptive Control, Self-Tuning Controller, Indirect Adaptive Control, Predictive Control, Real-World Applications of Neural Networks, Introduction to Deep Learning. **[10 Hrs.]**

Fuzzy Logic: Introduction to classical sets - properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, Operations, properties, fuzzy relations, cardinalities, membership functions. **[10 Hrs.]**

Fuzzy Logic System: Components, Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods. Choice of fuzzification procedure, Choice of defuzzification procedure, nonlinear fuzzy control, Adaptive fuzzy control. Hybrid Systems: Neuro-Fuzzy and Fuzzy-Neural Models, Concepts of Soft Computing and Computational Intelligence, Designing a Neuro-Fuzzy System for Real-World Applications. **[10 Hrs.]**

Text books:

1. Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications, by S. Rajasekaran and G. A. Vijayalakshmi Pai, 2nd Edition, PHI Learning, 2003.
2. Soft Computing: Neuro-Fuzzy and Genetic Algorithms by Samir Roy and Udit Chakraborty, 1st Edition, Pearson, 2006.

Reference books:

1. Introduction to Artificial Intelligence and Expert Systems by Dan W. Patterson, 3rd edition, Prentice-Hall International, 2000.
2. Introduction to Artificial Systems by J. M. Zurada, 5th Edition, Jaico Publishing House, 2004.
3. An Introduction to Neural Networks by James A. Anderson, 2nd edition , Prentice Hall of India, New Delhi, 1999.
4. S. Haykin, Neural Networks: A Comprehensive Foundation, Prentice- Hall India, 2nd Edition, 1999.

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

IN356NB: ANALYTICAL INSTRUMENTATION

Teaching Scheme : 03 L + 00 T; Total: 03 hours/week **Credits** : 03
Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This course provides the knowledge of different analytical methods used in chemical analysis and role of instrumentation in it.

DESIRABLE AWARENESS / SKILLS

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COURSE OUTCOMES

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

1. Understand the capabilities and limitations of analytical instruments
2. Learn the advances in analytical instrumentation
3. Select and apply an analytical instrument in the physical, chemical and biological world
4. Analyse and select proper instrument and appreciate the role of instrumentation for given application

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	3	1	-	-	-	-	-	-	-	-	-	2	1	-
2	3	1	-	-	1	-	-	-	-	-	-	2	2	-
3	2	2	2	1	2	-	1	-	-	-	-	3	3	1
4	2	3	2	2	-	1	-	-	-	-	-	2	3	2

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Chemical Analysis and Analytical methods

Classification of Analytical Methods: Classical and instrumental methods, comparison of these methods, classification of instrumental methods (spectral, electro analytical and separative methods) [**4 Hrs.]**

Spectrometric Methods:

Laws of photometry, Beer and Lambert's law, monochromator design and monochromator performance, colorimeters, single beam and double beam spectrophotometers, dual wavelength and double monochromatic systems, direct reading multichannel spectrophotometers, diode array rapid scanning spectrophotometers, reverse optics technique, IR spectroscopy, Instrumentation, sources, detectors, FTIR. Raman Spectrometry, Raman effect, Raman spectrometer components, LASER Raman spectrophotometer Emission and Absorption Spectroscopy. **[8 Hrs.]**

Emission Spectroscopy:

Principle of emission spectroscopy, sources of excitation, DC arc, AC arc, AC spark and Plasma excitation sources, Flame photometry, Atomic Absorption Spectroscopy (AAS), optical and electronic systems, interferences in AAS, applications. **[4 Hrs.]**

Nuclear Magnetic Resonance (NMR) Spectrometry:

Principle, nuclear spin, nuclear energy levels, resonance condition, NMR absorption spectra, chemical shift, constructional details of NMR spectrometer, sensitivity enhancement techniques, spin decoupler, Fourier transform NMR spectroscopy; **[4 Hrs.]**

Mass Spectrometry:

Principle and components of mass spectrometer. magnetic deflection type, time of flight, radio frequency, double focusing, quadrupole type, gas chromatograph mass spectrometer (GCMS) system resolution of mass spectrometer, applications in industry. **[4 Hrs.]**

Electron and Ion Spectroscopy:

Surface spectroscopic techniques, electron spectroscopy for chemical analysis (ESCA), Auger spectroscopy (AES), Secondary ion mass spectrometry (SIMS) and ion scattering spectroscopy (ISS). Radio Chemical Instrumentation: Radio chemical methods, radiation detectors, ionization chamber, Geiger Muller counter, proportional counter, scintillation counter, semiconductor detectors, pulse height analyzer. Electron Spin Resonance (ESR) Spectrometry. **[6 Hrs.]**

X-ray Spectrometry:

X-ray spectrum, Instrumentation for X-ray spectrometry, X-ray diffractometers, X-ray absorption meter. X-Ray fluorescence spectrometry. Electron probe microanalyzer. **[4 Hrs.]**

Chromatography:

Classification, Basic definitions**.** Principle and basic parts of gas chromatograph. Components of gas chromatograph, temperature programming. Detectors-thermal conductivity, flame ionization, electron capture. Liquid Chromatography: Introduction and its classification, HPLC, Applications of Chromatographs in industries such as process, food and pharmaceuticals. **[6 Hrs.]**

Text Books:

1. Handbook of Analytical Instruments by R.S. Khandpur, Second ed., 2006. Tata McGrawHill.
2. Instrumental Methods of Analysis by Willard, Merritt, John Aurie Dean, CBS Publishers & Distributors, New Delhi, Seventh ed., 1988.
3. Instrumental Methods of Chemical Analysis by B. K. Sharma, Goyal publications house Meerut , 23th edi., 2004.

Reference Books:

1. Principles of Industrial Instrumentation by D. Patranabis, second edition, Tata McGraw
2. Instrumental Methods of Chemical Analysis by G. W. Ewing, 4th Edi, McGraw Hill, 1975.
3. Analytical Instrumentation Handbook by Bela G Liptak, Chilton, Second ed., 1994.
4. Principles of Instrumental Analysis by Skoog, Holler, Nieman, Thomson books-cole publications, Sixth ed., 2006.

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

IN356NC OPTOELECTRONIC INSTRUMENTATION

Teaching Scheme : 03 L + 0 T; Total: 03 hours/week **Credits** : 03
Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This course provides an overall exposure to the technology of Industrial Automation as widely seen in factories of all types both for discrete and continuous manufacturing.

DESIRABLE AWARENESS / SKILLS

Introduction to Photonics (preferable)

COURSE OUTCOMES

On the successful completion of this course, students will be able to -

1. Understand the principle of total internal reflection and its role in fiber optic transmission
2. Examine signal attenuation and losses due to absorption, scattering, bending, and coupling.
3. Describe the working principles of different optical sources like LEDs and laser
4. Analyze the sensing mechanisms of fiber optic sensors for different measurement techniques.
5. Understand the industrial applications of Lasers.

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs

(WITH STRENGTH OF CO-RELATION)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	-	-	1	-	-	1	2	-
CO2	2	3	2	1	2	1	-	-	-	-	1	3	1	-
CO3	3	2	2	1	3	1	3	1	2	-	-	2	2	1
CO4	2	2	1	1	1	-	-	-	-	2	-	2	2	1
CO5	3	2	2	1	-	-	1	1	1	-	-	3	2	1
CO6		2			1						1		2	

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Introduction: General optical fiber communication system, Principle of light propagations through a fiber, different types of fibers and their properties. advantages, disadvantages and applications of optical fiber communication, Fiber materials and their characteristics, protocols used in optical fiber communication like PROFINET, PROFIBUS etc. [**8 Hrs.]**

Transmission characteristics of fibers: Attenuation-absorption –scattering losses-bending losses-core and cladding losses-signal dispersion –inter symbol interference and bandwidth, intra-model dispersion, material dispersion, waveguide dispersion, polarization mode dispersion, intermodal dispersion. [**8 Hrs.]**

Measurement Techniques: Fiber optic instrumentation system, fiber optic sensors, different types of modulators. Application in instrumentation- Interferometric method of measurement, measurement of temperature, pressure, current, voltage, liquid level and strain. OTDR and its applications. Analog and digital communication link, Optical power budget [**8 Hrs.]**

Optical sources and detectors: Intrinsic and extrinsic material-direct and indirect band gaps, LED structures: surface emitting, edge emitting, Fundamental characteristics of Laser, three level and four level lasers, properties of laser, laser modes, optical resonator, Q switching, cavity dumping, mode locking, types of lasers, Detectors: PIN photo detector-Avalanche photo diodes-Photo detector noise-noise sources-SNR-detector response time [**8 Hrs.]**

Laser Applications: Laser for measurement of current, voltage and atmospheric effects, spatial frequency filtering. Holography basic principle, methods, holographic interferometry, Holography for non-destructive testing, Holographic components. Applications in material processing. Laser drilling, laser cutting, laser tracking, medical applications of laser, laser and tissue interaction, laser instrumentation for surgery. [**8 Hrs.]**

Reference books:

1. Optical fiber communications, John M. Senior, Pearson Publications, 2nd edition.
2. Optical fiber communications, Gerd Keiser, Tata McGraw Hill Pub, 4th edition.
3. Fiber Optic Communication- Systems and Components, Vivekanand Mishra and Sunita P. Ugale, Wiley-India Pub.
4. Laser Systems and Applications, Nityanand Chaudhary and Richa Verma, PHI Learning Pvt. Ltd.

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

IN357N: PROCESS INSTRUMENTATION LAB

Teaching Scheme : Practical 02; Total: 02 hours/week **Credits:** 01
Evaluation Scheme : 30 ICA + 20 ESE **Total Marks** : 50
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This course introduces the intellectual and motor skills of the students' .Acquire knowledge of selection of different control strategies for process loops. It is also capable to apply different methods of tuning PID controllers in the form of electrical, electronics and Pneumatic types. From this course students are able to handle different industrial control loops in the lab.

DESIRABLE AWARENESS / SKILLS

IN251N: ELECTRONIC MEASUREMENTS AND INSTRUMENTATION

COURSE OUTCOMES

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

1. Estimate the input variables, output variables, constraints and characteristics of processes and determine control objectives.
2. Derive, develop a mathematical model using fundamental laws and by performing experiments on prototype systems.
3. Design a PID controller using direct synthesis and IMC strategy for stable processes (either minimum or non-minimum phase). Tuning of PID controller using open loop process reaction curve method and closed loop ultimate cycle method.
4. Design Cascade, Ratio, Feed forward, Selective, Split range and Inferential Control. Understand physical realization limitations due to time delays and RHP zeros.
5. Determine the degree of interaction and proper input-output pairings that best suited for the control problem through the concept of relative gain array (RGA), and design a de-coupler controller

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	3			2								2	2	1
2	3	2					1	3		2		2	2	1
3	3	2	3	1					1	1	2	3	3	1
4	3	3			3	2						3	3	1
5	3	3	2	1	1	2		1			1	1	2	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Minimum **eight** experiments from the list of experiments provided below (Using hardware of control loops and MATLAB, SCILAB etc. wherever required.) shall be performed to cover entire curriculum of course. This course consists of minimum 8 experiments based on theory syllabus of **IN351N**. Experiments should involve simulation/performance/design of practical, result and conclusion based on it. The sample list given below is just a guide line.

List of Experiments:

1. Design of an electronic ON-OFF controller and plot the characteristics of natural zone of controller
2. Design an electronic PID controller and study its response for step input.
3. Study of Cascade Control trainer (Flow & Level control)
4. Level control trainer:
   a. Study of open loop response (Manual control)
   b. Study of on/off controller
   c. Study of proportional controller
   d. Study of proportional integral controller
   e. Study of proportional derivative controller
   f. Study of proportional integral derivative controller
   g. Tuning of controller (Open loop method)
   h. Tuning of controller (Closed loop method)
5. Flow control trainer
   a. Study of open loop response (Manual control)
   b. Study of on/off controller
   c. Study of proportional controller
   d. Study of proportional integral controller
   e. Study of proportional derivative controller
   f. Study of proportional integral derivative controller
   g. Tuning of controller (Open loop method)
   h. Tuning of controller (Closed loop method)
6. Design and Implementation of Cascade control loop for a given process.
7. Design and Implementation of Feed forward control for given process.
8. Design and Implementation of Model based controller for FOPDT system.
9. Design and Implementation IMC for FOPDT and SOPDT processes.
10. Design and Implementation of IMC based PID controller for delay free systems

Evaluation Methodology:

- **ICA –** It shall support for regular performance of practical and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on practical performed by him/her. The performance shall be assessed experiment wise using the prescribed internal continuous assessment format.
- **ESE –** It shall be based on performance in one of the experiments performed by student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners, out of which one examiner shall be external examiner.

IN358N: DISTRIBUTED CONTROL SYSTEM LAB

Teaching Scheme : Practical 02; Total: 02 hours/week **Credits:** 01
Evaluation Scheme : 30 ICA + 20 ESE **Total Marks** : 50
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This course consists of minimum 8 experiments based on theory syllabus of IN352N. Experiments should involve simulation/performance/design of practical, result and conclusion based on it. The sample list given below is just a guide line.

DESIRABLE AWARENESS / SKILLS

To understand operation of PLC,DCS and SCADA in process industries

COURSE OUTCOMES

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

1. Understand the basic operation and selection criteria of PLC.
2. How to develop the programming by using PLC.
3. Apply the concepts of process control to the automation of process.
4. Understand the basic of SCADA.

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	2	1				1			1			2	2	
2	2	1		1			1		1	2	3	2	2	
3	3	2	2	2	2							2	3	1
4	2	3	3	2	2	1		2	1		1	3	2	2

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Minimum **eight** experiments from the list of experiments provided below shall be performed to cover entire curriculum of course IN352N DCS.

List of Experiments:

1. Develop ladder logic program for AND / OR logic gate.
2. Develop ladder logic program for simple timer instruction .
3. Develop ladder logic program for simple counter instruction .
4. Implementation of Flow , Level, Pressure, Temp loop in DCS
5. Develop ladder logic program for stepper motor control.
6. Develop ladder logic program for interfacing of proximity switch.
7. Develop ladder logic program for interfacing sensor to PLC.
8. Develop ladder logic program for interfacing bottle filling plant to PLC.
9. Develop logic on DCS to implement cascade control.
10. Development of ladder diagram and simulation for the level control system.
11. Study of software package RSVIEW32 (AB make) for SCADA.
12. Development of mimic diagram for a particular process using SCADA software.
13. Development of FBD programs for ON/OFF control.

Evaluation Methodology:

- **ICA –** It shall support for regular performance of practical and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on practical performed by him/her. The performance shall be assessed experiment wise using the prescribed internal continuous assessment format.
- **ESE –** It shall be based on performance in one of the experiments performed by student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners, out of which one examiner shall be external examiner.

IN360NA: DIGITAL SIGNAL PROCESSING LAB

Teaching Scheme : Practical 02; Total: 02 hours/week **Credits:** 01
Evaluation Scheme : 30 ICA + 20 ESE **Total Marks** : 50
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This course consists of minimum 8 experiments based on theory syllabus of IN355N. Experiments should involve simulation/performance/design of practical, result and conclusion based on it. The sample list given below is just a guide line.

DESIRABLE AWARENESS / SKILLS

IN303N: signals and systems.

COURSE OUTCOMES

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

1. Sample and reconstruct any analog signal
2. Find frequency response of LTI system
3. Find Fourier Transform of discrete signals
4. Design of IIR & FIR filter and implementation of them

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	2					1			1					
2	1				2				2			3	2	2	
3	1	2							2						
4	1					1								2	

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Minimum **eight** experiments from the list of experiments provided below shall be performed to cover entire curriculum of course IN355N.

List of Experiments:

1. Implement the sampling theorem and aliasing effects by sampling an analog signal with various sampling frequencies.
2. To study the properties of DFT. Write programs to confirm all DFT properties.
3. To study the circular convolution for calculation of linear convolution and aliasing effect. Take two sequences of length
4. Write a program to find 4 point circular convolution and compare the result with 8 point circular convolution to study aliasing in time domain. 4. (a) To find Z and inverse Z transform and pole zero plot of Z-transfer function. (b) To solve the difference equation and find the system response using Z transform.
5. To plot the poles and zeros of a transfer function when the coefficients of the transfer function are given, study stability of different transfer functions.
6. To study the effect of different windows on FIR filter response. Pass the filter coefficients designed in experiment 6 via different windows and see the effect on the filter response.
7. Design Butterworth filter using Bilinear transformation method for LPF and write a program to draw the frequency response of the filter.
8. To plot the mapping function used in bilinear transformation method of IIR filter design.(assignment may be given)
9. Effect of coefficient quantization on the impulse response of the filter using direct form I and II realization and cascade realization.(theory assignment)
10. Design and implement two stage sampling rate converter.
11. Computation of DCT and IDCT of a discrete time signal and comment on energy compaction density.
12. To implement at least one of the following operations using DSP Processor i) Linear and Circular convolution. ii) Low pass filter an audio signal input to DSK with FIR filter. iii) Low pass filter an audio signal input to DSK with IIR filter. iv) To generate sine wave using lookup table with table values generated within the programmed.

Evaluation Methodology:

- **ICA –** It shall support for regular performance of practical and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on practical performed by him/her. The performance shall be assessed experiment wise using the prescribed internal continuous assessment format.
- **ESE –** It shall be based on performance in one of the experiments performed by student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners, out of which one examiner shall be external examiner.

IN360NB: MODERN CONTROL THEORY LAB

Teaching Scheme : Practical 02; Total: 02 hours/week **Credits:** 01
Evaluation Scheme : 30 ICA + 20 ESE **Total Marks** : 50
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This course consists of minimum 8 experiments based on theory syllabus of IN360N. Experiments should involve simulation/performance/design of practical, result and conclusion based on it. The sample list given below is just a guide line.

COURSE OUTCOMES

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

1. Study the system performance by selecting a suitable controller and/or a compensator for a specific application.
2. Understand the different ways of system representations such as transfer function representation and state space representations and to assess the system dynamic response.
3. Study system controllability and observability using state space representation and applications of state space representation to various systems.
4. To design various controllers and compensators to improve system performance.

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	3	1	--	--	--	--	3	3	--	--	3	1	3	**2**
2	3	2	--	--	--	--	--	3	--	--	3	2	2	**2**
3	3	2	--	--		--	--	3	--	--	3	1	1	**2**
4	3	1	3	--	3	--	--	3	--	--	3	1	3	**2**

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Minimum **eight** experiments from the list of experiments provided below shall be performed to cover entire curriculum of course IN360N.

List of Experiments:

1. Simulation of integrator and differentiator circuit using MATLAB.
2. State space model for classical transfer function using MATLAB
3. Determine State Space Model of a given system.
4. Test for Controllability and Observability by using MATLAB.
5. Performance of P, PI and PID Controller on system response.
6. Stability analysis of linear time invariant system using MATLAB
7. Determination of steady state error using MATLAB
8. To determine state transition matrix of a given system.
9. To Draw the phase characteristic of given Non-linear system.
10. Conversion of transfer functions to state model of discrete time systems.

Evaluation Methodology:

- **ICA –** It shall support for regular performance of practical and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on practical performed by him/her. The performance shall be assessed experiment wise using the prescribed internal continuous assessment format.
- **ESE –** It shall be based on performance in one of the experiments performed by student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners, out of which one examiner shall be external examiner.

IN360NC: INSTRUMENTATION SYSTEM DESIGN LAB

Teaching Scheme : Practical 02; Total: 02 hours/week **Credits:** 01
Evaluation Scheme : 30 ICA + 20 ESE **Total Marks** : 50
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

Instrumentation system design course involves specifying equipment, layouts, and wiring. This course explores the selection criteria for transducers used in measuring displacement, flow, temperature, and other parameters. It covers design considerations for transducers such as thermocouples, RTDs, orifice plates, and rotameters. Additionally, it includes the design of controllers and control panels

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	3				1		1		1			2	2	1
2	3	2									1	2	2	1
3	3	2	3				2		1	2		3	3	1
4	3	3			3	2						3	3	1
5	3	3	2	1	1	2		1			1	1	2	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Minimum **eight** experiments from the list of experiments provided below (shall be performed to cover entire curriculum of course. This course consists of minimum 8 experiments based on theory syllabus of **IN355NC**. Experiments should involve simulation/performance/design of practical, result and conclusion based on it. The sample list given below is just a guide line.

List of Experiments:

1. Design of signal conditioning circuit for resistive displacement transducer.
2. Design of signal conditioning circuit for Capacitive/Inductive displacement transducer.
3. Design signal conditioning circuit for strain gauge
4. . Design of signal conditioning for load cell
5. Design of signal conditioning circuit for RTD (Pt-100)
6. Design of signal conditioning for thermocouple (J/K/R/S/T/E Type)
7. Calibration of I/P & P/I converter
8. Calibration of D.P. Transmitter for flow
9. Calibration of D.P. Transmitter for level
10. Study of Smart transmitter.
11. Enclosure design for circuit and instrument.
12. Design electronic PID controller.
13. Any other experiments related to the subject.
14. Practical related to reliability engineering.

Evaluation Methodology:

- **ICA –** It shall support for regular performance of practical and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on practical performed by him/her. The performance shall be assessed experiment wise using the prescribed internal continuous assessment format.
- **ESE –** It shall be based on performance in one of the experiments performed by student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners, out of which one examiner shall be external examiner.

IN361NA NEURAL NETWORK AND FUZZY LOGIC LAB

Teaching Scheme : Practical 02; Total: 02 hours/week **Credits:** 01
Evaluation Scheme : 30 ICA + 20 ESE **Total Marks** : 50
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This course introduces the basic theories and techniques for neural network and fuzzy logic. The course is primarily meant to develop on hand experience in applying these basics to the detail neural and fuzzy logic based system.

Minimum Ten experiments shall be performed to cover entire curriculum of course IN356NA NEURAL NETWORK AND FUZZY LOGIC. The list given below is just a guideline.

List of Experiment:

1. Write a program to implement and train single layer perception algorithm using MATLAB/Python.
2. Write a program to implement and train multilayer perception algorithm using MATLAB/Python.
3. Implement and compare different activation functions (ReLU, Sigmoid, Softmax, Tanh).
4. Write a program to implement and train back propagation learning algorithm
5. Design multilayer feed forward network using back propagation algorithm
6. To study fuzzy logic controller using fuzzy logic toolbox
7. To Study various defuzzification techniques
8. Design of control system using fuzzy logic toolbox.
9. Write a program to implement of fuzzy set operation.
10. Applications and analysis of process using fuzzy system.
11. Applications and analysis of process using fuzzy PID system.
12. Applications and analysis of MIMO process using fuzzy system.
13. Develop a complete ANN-based project.
14. Type II fuzzy toolbox based control applications.
15. Design a fuzzy controller for temperature control of an air conditioner.
16. Develop a multi-criteria decision-making system using fuzzy logic.
17. Implement a Hybrid Fuzzy-Neural System for function approximation.
18. Develop a full fuzzy logic-based project, such as: i) Smart irrigation system using fuzzy logic. ii) AI-based fuzzy recommendation system. iii) Fuzzy logic-based chatbot for decision-making.

Note:

● **ICA –** Internal Continuous Assessment shall support for regular performance of practical and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on practical performed by him/her. The performance shall be assessed experiment wise using internal continuous assessment format. **(S 10).**

● **ESE –** The End Semester Examination (ESE) for this laboratory course shall be based on performance in one of the experiments performed by student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners out of which one examiner shall be out of institute.

IN361NB: ANALYTICAL INSTRUMENTATION LAB

Teaching Scheme : Practical 02; Total: 02 hours/week **Credits:** 01
Evaluation Scheme : 30 ICA + 20 ESE **Total Marks** : 50
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

In this laboratory, course emphasis on imparting the practical knowledge and understanding of analytical instruments for qualitative and quantitative analysis

COURSE OUTCOMES

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

1. Understand the capabilities and limitations of analytical instruments
2. Learn the advances in analytical instrumentation
3. Select and apply an analytical instrument in the physical, chemical and biological world
4. Analyze and select proper instrument and appreciate the role of instrumentation for given application

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	2	2	-	1	-	-	-	-	2	-	1	2	-	-
2	3	3	3	3	3	1	-	1	-	3	1	3	-	2
3	2	3	3	3	3	-	-	-	1	-	-	3	1	2

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Minimum **eight** experiments from the list of experiments provided below shall be performed to cover entire curriculum of course EE203N.

List of Experiments:

1. Study of filter photometer.
2. Study of flame photometer.
3. Study of Densitometer.
4. Study of spectrophotometer (visible and infra-red region)
5. Study of single beam spectrophotometer for UV/VIS range.
6. Study of double beam spectrophotometer for UV/VIS range.
7. Study of mass spectrometers.
8. Study of gas chromatographs.
9. Study of liquid chromatographs.
10. Study of N.M.R. and E.S.R. spectrometer.
11. Study of atomic absorption spectrophotometer.
12. Study of Refractometer.

Evaluation Methodology:

- **ICA –** It shall support for regular performance of practical and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on practical performed by him/her. The performance shall be assessed experiment wise using the prescribed internal continuous assessment format.
- **ESE –** It shall be based on performance in one of the experiments performed by student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners, out of which one examiner shall be external examiner.

IN361NC OPTOELECTRONIC INSTRUMENTATION LAB

Teaching Scheme : Practical 02; Total: 02 hours/week **Credits:** 01
Evaluation Scheme : 30 ICA + 20ESE **Total Marks** : 50
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This laboratory course will enable students to relate what they have learnt in classroom to experimental observations. It gives hands-on practice to calculate fiber properties and losses. OTDR used for measurement techniques, data analysis and fault detection.

Minimum Ten experiments shall be performed to cover entire curriculum of course IN356NC OPTICAL INSTRUMENTATION. The list given below is just a guideline.

List of Experiment:

1. To study attenuation losses in optical fiber.
2. To study bending losses in optical fiber.
3. Measurement of numerical aperture of an optical fiber.
4. Study of analog fiber optic communication link.
5. Study of digital fiber optic communication link.
6. To study characteristic curve for optical source and detector.
7. Study of Nd-Yag Laser.
8. Study of OTDR and measurement techniques on OTDR.
9. To measure the length of fiber using one fiber spool and analysis using OTDR.
10. Study of intensity modulation techniques in fiber.

Evaluation Methodology:

● **ICA –** Internal Continuous Assessment shall support for regular performance of practical and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on practical performed by him/her. The performance shall be assessed experiment wise using internal continuous assessment format. **(S 10).**

● **ESE –** The End Semester Examination (ESE) for this laboratory course shall be based on performance in one of the experiments performed by student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners out of which one examiner shall be out of institute.

IN362N: MINI PROJECT

Teaching Scheme: 04 P ; Total: 04 **Credits:** 02
Evaluation Scheme: 30 ICA + 20 ESE **Total Marks:** 50
ESE Duration: 3 Hrs

COURSE DESCRIPTION:

The mini project is one of the most important single piece of work in the degree programme. It is introduced in curriculum to put into practice some of the techniques that have been taught to students in earlier years. It also provides the opportunity to students to demonstrate independence and originality, to plan and organise a large project over a long period. The mini-project topic should be selected to ensure the satisfaction of the need to establish a direct link between the techniques they learnt and productivity. Thus it should reduce the gap between the world of work and the world of study.

DESIRABLE AWARENESS/SKILLS:

Knowledge of concepts, principles and techniques studied in all earlier courses.

COURSE OUTCOME:

On successful completion of this course students shall be

1. able to apply the knowledge and skills previously gained into practice.
2. take appropriate decision wrt various parameters related to production of a system or sub-system.
3. demonstrate the leadership quality along with ability to work in a group.
4. prove the ability to present the findings in a written report or oral presentation.

RELEVANCE OF POS AND STRENGTH OF CORRELATION:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	-	-	-	-	-	-	-	2	1	3	2	-
CO2	3	1	-	-	-	1	-	3	-	-	-	3	2	-
CO3	2	3	2	3	2	-	-	1	-	1	-	2	2	1
CO4	2	2	3	2	-	-	-	-	2	-	2	2	2	2
CO5	2	2	3	2	2	1		3	-	-	1	2	2	2

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

- The mini project shall be carried out in-house i.e. in the department's laboratories/centres by a group 2 – 4 students. In any case the group shall not consist of more than four students.
- The mini project shall consist of design and implementation of any suitable electrical / electronic system, sub system or circuit based on knowledge and skills previously gained.
- The mini project outline (a brief or condensed information giving a general view of mini project topic) on the selected topic should be submitted to the course coordinator for approval within one weeks from the commencement of the term.
- Students are expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation.
- **Mini Project Deliverables:** A mini project report as per the specified format (available on in the department and institutes website), developed system in the form of hardware and/or software. In addition, student shall maintain a record of attendance and continuous progress (log book in appropriate format available on institute/department's web site) duly signed by course coordinator and present as mini project deliverable along with report.

Evaluation System:

It includes Internal Continuous Assessment (ICA) and End Semester Examination (ESE). Guidelines for ICA and ESE are given bellow.

Internal Continuous Assessment (ICA)

- The ICA shall be evaluated by course coordinator.
- Course coordinator shall judge the students on the principle of continuous evaluation and contribution of individual student in the group.
- It shall be evaluated on the basis of deliverables of mini project and depth of understanding.
- Course coordinator shall maintain the record of continuous evaluation in appropriate format available on institute/department's web site.

End Semester Examination (ESE)

- The End Semester Examination for this course shall be based on demonstration of the system or sub system developed by the group of students, deliverables of mini project and depth of understanding (oral examination). It shall be evaluated by two examiners out of which one examiner shall be out of institute.

IN363N: CONTROL OF ROBOTIC SYSTEM

Teaching Scheme : 03 L + 00 T; Total: 03 hours/week **Credits** : 03
Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100
ESE Duration : 3 Hrs.

COURSE DESCRIPTION:

This course will introduce to students the skills and knowledge to analyze kinematics, dynamics of robotic systems and use it for control design.

COURSE OUTCOMES:

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

1. Ability to understand basic concept of robotics.
2. Know about the dynamics and control in robotics industries
3. Analyze system stability and types of stability
4. Understand the concept of nonlinear control and observer schemes

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	1	1	--	1	--	--	--	1	--	--	--	1	2	--
2	1	1	--	--	--	1	--	1	--	1	2	1	1	1
3	2	2	2	1		1		1	2	1	1	--	1	1
4	3	3	2	1		2	1	1		1	1	1	1	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Simple manipulators: Two /three arm manipulators and their kinematics equations, Work space Homogeneous Transformation: Rotation, Translation, and Composition of homogeneous transformations **[7 Hrs.]**

Danavit-Hartimber Algorithm: D-H procedure for fixing joint coordinate frames, Robot parameters, Arm matrix, Inverse Kinematics for PUMA, SCARA manipulators. **[6 Hrs.]**

Introduction to Robotic Exoskeletons: Optimal Design of a Three Finger Exoskeleton for Rehabilitation Purpose **[6 Hrs.]**

Differential transformation and velocity of a frame: Derivative of a frame, Velocity, Jacobian, Inverse Jacobian, Trajectory Planning: Polynomial trajectory, Biped trajectory **[7 Hrs.]**

Dynamics: Lagrangian method, Robot dynamics equation, Control: Robot dynamics equation as a control system, Trajectory tracking control, PD controller, neural network control design **[7 Hrs.]**

Redundancy Resolution of Human Fingers using Robotic Principles, Manipulability Analysis of Human Fingers during Coordinated Object Rotation, Kinematics of Flexible Link Robots. **[7 Hrs.]**

Text Books

1. S. K. Saha, "Introduction to Robotics", Tata McGraw Hill Education Pvt. Ltd., New Delhi.
2 R. K. Mittal, I. J. Nagrath, "Robotics and Control", Tata McGraw-Hill Publishing Company Ltd.
3 R Kelly, D. Santibanez, LP Victor and Julio Antonio, ―Control of Robot Manipulators in Joint Space‖, Springer, 2005.

Reference Books

1. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers,Chennai, 1998.
2. R.D.Klafter, T.A.Chimielewski and M.Negin, Robotic Engineering–An Integrated Approach, Prentice Hall of India, New Delhi, 1994.
3. Modern control system M.Gopal, TATA McGraw Hill Company
4. J J Craig, ―Introduction to Robotics: Mechanics and Control, Prentice Hall, 4 th Ed, 2018.

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

IFM301N FUNDAMENTALS OF INDUSTRY 4.0

Teaching Scheme : 03 L + 0 T; Total: 03 hours/week **Credits** : 04
Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

This course provides the fundamentals of industrial revolutions and the holistic perspective of the underlying concept of Industry 4.0 – a paradigm shift to the production of the future that integrates automation technology and information technology to enhance productivity, efficiency and flexibility in manufacturing processes.

COURSE OUTCOMES

On the successful completion of this course, students will be able to -

1. Describe Industry 4.0 and scope for Indian Industry
2. Demonstrate conceptual framework and road map of Industry 4.0
3. Describe Robotic technology and Augmented reality for Industry 4.0
4. Demonstrate obstacle and framework conditions for Industry 4.0

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs

(WITH STRENGTH OF CO-RELATION)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	2	-	2	-	-	1	2	-
CO2	2	3	2	1	2	1	-	2	1	2	2	3	1	-
CO3	3	2	2	1	3	1	-	-	-	-	-	2	3	1
CO4	2	2	1	1	1	-	1	-	-	-	1	2	2	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Introduction to Industry 4.0: Introduction, core idea of Industry 4.0,origin concept of industry 4.0,Industry 4.0 production system, current state of industry 4.0, Technologies, How is India preparing for Industry 4.0 **[8 Hrs.]**

A Conceptual Framework for Industry 4.0: Introduction, Main Concepts and Components of Industry 4.0, State of Art, Supportive Technologies, Proposed Framework for Industry 4.0.

[8 Hrs.]

Technology Roadmap for Industry 4.0: Introduction, Proposed Framework for Technology Roadmap, Strategy Phase, Strategy Phase, New Product and Process Development Phase.

[8 Hrs.]

Advances in Robotics in the Era of Industry 4.0: Introduction, Recent Technological Components of Robots- Advanced Sensor Technologies, Internet of Robotic Things, Cloud Robotics, and Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications- Manufacturing, Maintenance and Assembly **[8 Hrs.]**

The Role of Augmented Reality in the Age of Industry 4.0: Introduction, AR Hardware and Software Technology, Industrial Applications of AR. **[8 Hrs.]**

Obstacles and Framework Conditions for Industry 4.0 : Lack of A Digital Strategy alongside Resource Scarcity, Lack of standards and poor data security, Financing conditions, availability of skilled workers, comprehensive broadband infra- structure, state support, legal framework, protection of corporate data, liability, handling personal data. **[8 Hrs.]**

Reference books:

1. Alp Ustundag and Emre Cevikcan,"Industry 4.0: Managing the Digital Transformation".
2. Bartodziej, Christoph Jan,"The Concept Industry 4.0".
3. Klaus Schwab,"The Fourth Industrial Revolution".
4. Christian Schröder ,"The Challenges of Industry 4.0 for Small and Medium-size Enterprises".

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

IFM302N: ARTIFICIAL INTELLIGENCE: PRINCIPLES AND TECHNIQUES

Teaching Scheme	**:** 04 L + 00 T; Total: 04 hours/week	**Credits**	**:** 04
Evaluation Scheme	**:** 10 ISA + 30 MSE + 60 ESE	**Total Marks**	**:** 100
ESE Duration	**:** 3 Hrs.		

COURSE DESCRIPTION

This course provides a brief introduction to students that Artificial Intelligence (AI) aim to imbue machines with human-like capabilities such as sensing, comprehension, and action. These technologies are rapidly evolving and reshaping economies and societies worldwide.

DESIRABLE AWARENESS / SKILLS

IFM302N: Artificial Intelligence: Principles and Techniques.

COURSE OUTCOMES

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

1. Understand foundational concepts and gain practical experience with state-of-the-art AI methodologies.
2. Evaluate the reliability, dependability, and ethical considerations of AI.
3. Develop AI systems for complex planning, decision-making, and learning, addressing domain-specific challenges with reasoned solutions.
4. Create AI applications optimized for resource-constrained environments.
5. Adhere to ethical guidelines and privacy regulations across diverse domains and regions.

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	3	2	2	2	3	2	2	3	1	1	1	2	1	2
2	2	1	1	1	2	2	2	3	1	1	1	2	1	1
3	2	2	3	2	3	2	2	2	1	1	1	3	1	2
4	2	2	2	2	2	2	2	3	1	1	1	2	2	2
5	1	1	1	1	1	2	2	3	1	1	1	1	1	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Introduction:–Definition–Future of Artificial Intelligence, AI problems, foundation of AI and history of AI intelligent agents: Agents and Environments, the concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation. **[8 Hrs.]**

Searching: - Searching for solutions, uniformed search strategies – Breadth first search, depth first Search. Search with partial information (Heuristic search) Hill climbing, A*, AO* Algorithms, Problem reduction, Game Playing-Adversial search, Games, mini-max algorithm, optimal decisions in multiplayer games, Problem in Game playing, Alpha-Beta pruning, Evaluation functions. **[8 Hrs.]**

.

Knowledge Representation:- First Order Predicate Logic, Prolog Programming, Unification Forward Chaining, Backward Chaining, Resolution, Knowledge Representation, Ontological Engineering, Categories and Objects, Events: Mental Events and Mental Objects, Reasoning Systems for Categories, Reasoning with Default Information. **[8 Hrs.]**

Software Agents: - Architecture for Intelligent Agents, Agent communication, Negotiation and Bargaining, Argumentation among Agents, Trust and Reputation in Multi-agent systems. . **[8 Hrs.]**

Applications:- AI applications, Language Models, Information Retrieval, Information Extraction, Natural Language Processing, Machine Translation, Speech Recognition, Robot, Hardware, Perception, Planning, Moving **[8 Hrs.]**

Text Books

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach, Prentice Hall, Third Edition, 2009.
2. Artificial Intelligence: A Modern Approach, 4th Edition, Stuart Russell, peter Norvig University of California at Berkeley, Pearson education, 2020.
3. I. Bratko, ―Prolog: Programming for Artificial Intelligence, Fourth Edition, Addison-Wesley Educational Publishers Inc., 2011.

Reference Books

1. S. Russel and P. Norvig, “Artificial Intelligence – A Modern Approach”, SecondEdition, Pearson Education
2. David Poole, Alan Mackworth, Randy Goebel, ”Computational Intelligence : A logical approach”, Oxford University Press.
3. G. Luger, “Artificial Intelligence: Structures and Strategies for complex problemsolving”, Fourth Edition, Pearson Education.
4. J. Nilsson, “Artificial Intelligence: A new Synthesis”, Elsevier Publishers.
5. M. Tim Jones, ―Artificial Intelligence: A Systems Approach (Computer Science),

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

AFM 103: Agriculture Internet of Things and Applications

Teaching Scheme	**:** 03 L + 00 T; Total: 03 hours/week	**Credits**	**:** 03
Evaluation Scheme	**:** 10 ISA + 30 MSE + 60 ESE	**Total Marks**	**:** 100
ESE Duration	**:** 3 Hrs.		

COURSE DESCRIPTION:

This course explores the integration of the Internet of Things (IoT) in modern agriculture to enhance productivity, sustainability, and resource efficiency. Students will learn about IoT principles, sensor technologies, communication networks, and data analytics, focusing on their application in smart farming.

COURSE OUTCOMES:

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

1. Understand the IoT principal and its role in transforming traditional agricultural practices.
2. Evaluate different IoT architectures, communication protocols, and sensor technologies relevant to smart agriculture.
3. Develop IoT-based systems for precision agriculture, including crop monitoring, irrigation management, and livestock tracking.
4. Apply data collection, analysis, and visualization techniques to optimize agricultural processes
5. Demonstrate the integration of IoT with other technologies, such as artificial intelligence and cloud computing, for advanced agricultural applications.

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	2	1	1	2	2	2	2	2	2	2	2	2	1	2
2	2	2	2	2	2	2	2	2	1	1	1	1	1	2
3	3	2	2	2	3	2	2	3	2	2	1	3	2	2
4	3	2	2	3	3	2	2	3	2	2	1	2	2	2
5	3	2	2	3	3	2	3	3	2	2	2	3	1	2

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Introduction to IoT in Agriculture **[8 Hrs.]**

Overview of IoT and its evolution in agriculture, Introduction to Smart Agriculture and Its Importance, Evolution of Agricultural Practices: From Traditional to Smart Farming, Importance of IoT in modern farming practices, Benefits and challenges of IoT adoption in agriculture, Global Trends in IoT-based Agriculture

IoT Architecture and Components **[8 Hrs.]**

IoT architecture: Edge, fog, and cloud computing, IoT Devices and Components in Agriculture: Sensors: Soil moisture, temperature, humidity, pH, etc. Actuators for Automation. Communication protocols: Wi-Fi, Bluetooth, Zigbee, LoRaWAN, and NB-IoT. Data Acquisition and Real-time Monitoring Systems.

Advanced IoT Technologies in Agriculture **[8 Hrs.]**

IoT integration with Artificial Intelligence (AI) and Machine Learning (ML). Blockchain for agricultural supply chain management, Cloud platforms for IoT in agriculture, Role of 5G in enhancing IoT in agriculture

IoT Applications in Agriculture **[8 Hrs.]**

Precision Farming, Irrigation Management, Livestock Monitoring, Smart Greenhouses, Pest and Disease Management, Supply Chain Management.

Benefits and Challenges of IoT in Agriculture **[8 Hrs.]**

Benefits: Enhancing Crop Yield and Quality, Cost Efficiency and Resource Optimization, Sustainability and Environmental Conservation, **Challenges:** Connectivity Issues in Rural Areas, High Cost of IoT Implementation, Scalability and Interoperability of IoT Systems, Data Privacy and Cyber security Concerns, Lack of Awareness and Technical Skills Among Farmers.

Text Books

1. Internet of Things and Machine Learning in Agriculture, Dr. Vishal Jain and Jyotir Moy Chatterjee, Nova Science Publications.
2. Agricultural Internet of Things: Technologies and Applications, Springer Nature Switzerland AG; 1st ed. 2021 edition (3 August 2021)

Reference Books

1. Internet of Things for Agriculture 4.0Impact and Challenges Rajesh Singh, Amit Kumar Thakur, Anita Gehlot, Ajay Kumar Kaviti

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus
ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus

AFM104: REMOTE SENSING TECHNOLOGIES

Teaching Scheme	**:** 03 L + 00 T; Total: 03 hours/week	**Credits**	**:** 03
Evaluation Scheme	**:** 10 ISA + 30 MSE + 60 ESE	**Total Marks**	**:** 100
ESE Duration	**:** 3 Hrs.		

COURSE DESCRIPTION

This course provides a brief introduction to understand the principles, technologies, and applications of remote sensing, including optical, thermal, and microwave sensing, and to explore the advancements and future trends in remote sensing.

DESIRABLE AWARENESS / SKILLS

AFM104: Remote Sensing Technologies

COURSE OUTCOMES:

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

1. Gain foundational knowledge of remote sensing principles.
2. Learn the principles of thermal radiation, sensor functions, and image interpretation and correction.
3. Understand microwave sensing concepts, polarization, sensor types, and radar system characteristics.
4. Develop expertise in optical resolutions, platforms, sensors, and data acquisition techniques.
5. Become familiar with the history, characteristics of satellite missions, and recent advancements in remote sensing technology.

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	3	1	1	1	1	1	2	2	1	1	1	2	1	3
2	2	2	2	2	2	1	1	2	1	1	1	3	1	2
3	2	2	2	2	2	2	1	2	1	1	1	1	1	2
4	3	2	2	2	2	2	1	3	1	1	1	2	2	2
5	2	2	2	2	2	2	1	2	2	2	2	2	1	2

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

COURSE CONTENT

Fundamentals of Remote Sensing: Definition of Remote Sensing: Principles of Remote Sensing, History of Remote Sensing. Electromagnetic Radiation, Radiation Laws, EM spectrum. Interaction of EMR: With atmosphere, Atmospheric Windows, imaging spectrometry, Interaction with Earth. Spectral signature of various land cover features. **[8 Hrs.]**

Remote sensing data products and their procurement, Ground truth collection: - spectral signatures, commonly used ground truth equipments: - use of radiometers, Display forms: computer printouts, thematic maps, dot density maps **[8 Hrs.]**

Optical Remote Sensing: Resolutions: (Spectral, Spatial, Temporal and Radiometric Resolutions), Platforms:- (Aerial and Satellite), Sensors:- (imaging and non imaging Sensors), Data Acquisition:- (Signal Detection, Recording, Scanning Mechanisms and Orbiting Mechanisms of Satellites), Opto-mechanical scanners, Push broom and whiskbroom scanning, Panchromatic, multi spectral hyper spectral scanners. **[8 Hrs.]**

Thermal Remote Sensing: Basics of Thermal Remote Sensing, Thermal radiation principles, Temperature from Radiance Values, Thermal Sensors, Scanners, Optomechanical CCD Arrays, Aerial thermal images, Image characters, spatial and radiometry, Sources of image degradation, Radiometric and geometric errors and correction, Interpretation of thermal image. **[8 Hrs.]**

Microwave Remote Sensing and LIDAR: Basic Concepts of Microwave Remote Sensing, Passive sensors, radiometers, active sensors, imaging and non-imaging, RADAR: Polarization property of microwaves, SLAR: System components and Geometric characteristics of SLAR imagery, spatial resolution, Synthetic Aperture Radar (SAR), LIDAR: basic concepts. **[8 Hrs.]**

Text Books

1. Campbell, J.B.2002: Introduction to Remote Sensing. Taylor Publications2. Network Analysis, M. E. Van Valkenburg, 3rd edition, Prentice Hall, 2001
2. Joseph George, 2003: Fundamentals of Remote Sensing. Universities Press

Reference Books

1. Curran, P. 1985: Principles of Remote Sensing, Longman, London
2. Joseph George, 2003: Fundamentals of Remote Sensing. Universities Press
3. Sabins, F.F.Jr., 1978: Remote Sensing Principles and interpretation, Freeman, Sanfrancisco.
4. Burney, S.S 1988: Application of Thermal Imaging, Adam Hilger Publications.
5. Iain H Woodhouse, "Introduction to Microwave Remote Sensing", Speckled Press, 1st edition, 2017, ISBN-13: 978-0415271233

ASSESMENT:

MSE: Mid Semester Exam will be based on 50% of the syllabus

ISA: ISA will be based on any two of following components-

1) Declared test
2) Surprise test
3) MCQ Test
4) Assignments
5) PPT presentation
6) Quiz
7) Fabrication of working model

However, apart from above components, the course coordinator can choose any other component and shall declare method of evaluation at beginning of course.

ESE: End Semester Exam will be based on 100% of the syllabus