SLIET LONGOWAL

1.2.3 -INSTRUMENTATION AND CONTROL ENGINEERING (PG-ICE)

PEIE-822A OPTIMAL AND ROBUST CONTROL

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: **illustrate** optimal control problems, their classification along with performance indices and their selection.

CO2: **assess** Lagrange multiplier, Euler Lagrange equation, Transversality condition, equality & inequality constraints for optimization problems.

CO3: **explain** the dynamic programming along with causality, optimality, invariant in bedding and various optimization methods.

CO4: **apply** various iterative methods of optimization on kalman filter design

CO5: **formulate** robust control system, its analysis and uncertain parameter, PID controller and designs examples.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
BLs	BL2	BL5	BL3	BL3	BL2

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	**Programme Outcomes (POs)**												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	3	1	-	-	1	-	1	3	-	1	1	1
CO2	3	3	2	1	1	2	1	1	3	2	2	2	1
CO3	3	1	2	-	1	2	2	2	2	1	2	3	2
CO4	3	2	2	1	2	3	1	2	2	2	-	2	3
CO5	3	3	2	3	1	3	2	2	3	3	3	3	2

Unit I

Introduction and Parametric Optimization: Introduction to optimal control problems, Classification of optimal control problems, performance indices for optimal control and their selection, Dynamic optimization using. (06 Hrs)

Calculus of variations: Lagrange multiplier, Euler Lagrange's equation for different conditions, Transversality conditions, Dynamic optimization with equality and inequality constraints. (06 Hrs)

Pontryegans Max/min Principle: Optimization using Pontryegans maximum (minimum) principles with special emphasis on Bang-Bang type system. (06 Hrs)

Dynamic Programming in Continuous Time: Developments of Hamilton Jacobi equation, Matrix Riccati equation, optimal control based on quadratic performance indices, Linear regulator and servomechanism problem. (06 Hrs)

Unit II

Dynamic programming in Discrete System: Dynamic programming multistage decision processes in continuous time. Principle of causality, Invariant in bedding & optimality. (06 Hrs)

Iterative Method of Optimization: Optimization using gradient methods and interactive techniques (steepest descent), Newton Raphson and Fletcher Powell. Introduction to multivariable system and decoupling, Introduction to Optimal Filters (Kalman Filter). (06 Hrs)

Robust Control System: Introduction, Robust Control System and System sensitivity, Analysis of Robustness, system with uncertain parameters, the design of robust control system, PID controllers, and the design of robust PID controlled systems, design examples. (12 Hrs)

Recommended Books:

Text Books:

1. M. Gopal, Modern Control System Theory, 2nd edition, John Wiley & Sons, 1993.
2. R.C. Drof and R.H. Bishop, Modern control System, 8th Edition, Pearson, 1998.

Reference Books:

1. A. P. Sage and C. C. White, Optimum Systems Control, 2nd edition Prentice-Hall, 1997.
2. B. D. O. Anderson and J. B. Moore, Optimum System Control, Prentice-Hall, 2007.

PEIE-822B COMPUTATIONAL ELECTROMAGNETICS

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: **differentiate** electromagnetic and electrostatic fields in terms magnetic flux, electric flux, magnetic field, electric field and maxwell equations.

CO2: **assess** computer added design (CAD) software package and its features for design problems.

CO3: **analyze** finite difference method in time domain by using CAD software.

CO4: **compute** finite element for various 3D and 2D geometrical shapes using CAD software.

CO5: **design** low frequency electrical machines such as rotating machines (both ac and dc), transformers and actuators in CAD software by utilizing finite element method.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
BLs	BL2	BL5	BL4	BL3	BL6

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	**Programme Outcomes (POs)**												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	3	2	1	1	2	1	1	3	2	2	2	1
CO2	3	3	3	3	3	3	1	-	2	3	3	3	1
CO3	3	3	3	3	2	2	2	2	3	1	3	3	3
CO4	3	3	3	3	3	3	2	1	3	3	3	3	2
CO5	3	3	2	3	1	3	2	2	3	3	3	3	2

Unit I

Introduction: Conventional design methodology, Computer aided design aspects–Advantages. (04 Hrs)

Electromagnetic and Electrostatics: Basic field equations, calculation of field distribution,flux linkage, Voltage induced, inductance, capacitance, and force/torque. Electric and magnetic potentials, boundary conditions, Maxwell's equations, diffusion equation. (08 Hrs)

CAD packages: Recent developments, processing, modeling, material characteristics,problem formulation, solution, Post processing, commercial packages. (06 Hrs)

Finite Difference Analysis-FDM: Finite Difference Method (FDM): Finite Difference Schemes, treatment of irregular boundaries, accuracy and stability of FD solutions, Finite-Difference Time-Domain (FDTD) method. (06 Hrs)

Unit II

Finite Element Analysis-FEM: Finite Element Method (FEM): overview of FEM, Variationaland Galerkin Methods, shape functions, lower and higher order elements, vector elements, 2D and 3D finite elements, efficient finite element computations. (12 Hrs)

Special Topics: hybrid methods, coupled circuit - field computations, electromagnetic -thermal and electromagnetic - structural coupled computations, solution of equations. (06 Hrs)

Applications: Applications: low frequency electrical devices, static / time-harmonic /transient problems in transformers, rotating machines, actuators. (06 Hrs)

Recommended Books:

Text Books:

1. J. M. Jin, The Finite Element method in Electromagnetics, John Wiley & Sons, 2014.
2. M.V.K. Chari and P.P. Silvester, Finite Elements in Electric and Magnetic Field Problems, Jon Wiley, 1980.

Reference Books:

2. D. A. Lowther and P. P. Silvester, Computer Aided Design in Magnetics, Springer-Verlag New York, 1986.
3. P. P. Silverster and Ronaldo L Ferrari, Finite Element for Electrical Engineers, Cambridge University Press, 1983.

SLIET LONGOWAL

1.2.3 -INSTRUMENTATION AND CONTROL ENGINEERING (PG-ICE)

PEIE-822C CONTROL SYSTEM DESIGN

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: **Describe** control system architecture in terms of SISO, MIMO, convexity and duality using state space model.

CO2: **Analyze** the reliability, robustness, sensitivity and stability of closed loop control systems using gain bounds.

CO3: **Design** compensators and controllers for real-world applications using Bode plots and root locus techniques.

CO4: **Construct** closed loop SISO, MIMO and non-linear systems using state variable method

Mapping COs/Bloom's Taxonomy Level (BLs)				
COs	**CO1**	**CO2**	**CO3**	**CO4**
BLs	BL2	BL4	BL6	BL6

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	**Programme Outcomes (POs)**												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	1	-	-	1	-	1	3	-	1	1	1
CO2	3	3	3	3	3	3	2	1	3	3	3	3	2
CO3	3	3	3	3	2	2	2	2	3	1	3	3	3
CO4	3	3	3	3	3	3	2	1	3	3	3	3	2

Unit I

Introduction: Control System Architecture, Design Specifications Functional in-equally specifications, multi-criteria optimization, norms of scalar & vector signals, norms of SISO LTI & MIMO LTI systems, state space methods for computing norms, design specifications assets, affine & convex sets and functions, closed loop convex design specifications, convexity & duality. (12 Hrs)

Design Specifications: Reliability & closed loop stability, I/O specifications, regulation specifications, actuator effort, combined effect of disturbances & commands, differential sensitivity specifications, robustness specifications via gain bounds. (12 Hrs)

Unit II

Compensators & Controllers Design: Selection criteria and design of lead, lag, lead-lag and cascade type of compensators using Root locus & Bode plots, Rate feedback. Controllers – configuration and fundamentals of design, cascade and feedback compensation using various controllers. (12 Hrs)

State Variable Feedback Design: Introduction to state variable analysis, controllability and observability, state feedback for SISO system, state feedback design of SISO system using control canonical form. State variable feedback _ steady state error analysis, Use of steady state error coefficients, design of state observers, Introduction to design of MIMO systems. Introduction to design of non-linear systems and software. (12 Hrs)

RECOMMENDED BOOKS:

Textbooks:

1. M. Gopal, Control Systems- Principle & Design, 4th edition, Tata McGraw-Hill, 2012.
2. J. J. D'Azzo, Linear Control Analysis & Design, 3rd edition, McGraw-Hill, 1988.

Reference Books:

1. J. A. Borrie, Modern Control Systems- A manual of Design Methods, Prentice Hall International.
2. S. P. and C. H. Barratt, Linear Controller Designs-Limits of Performance, 5th edition, Prentice Hall International, 1991.

SLIET LONGOWAL

1.2.3 -INSTRUMENTATION AND CONTROL ENGINEERING (PG-ICE)

PEIE-822D INTELLIGENT CONTROL

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Explain mathematical concepts behind the single and multi layer artificial neural networks (ANN).

CO2: Design controllers for practical applications using fuzzy set theory.

CO3: Assess evolutionary computation algorithms for controller design

CO4: Construct an intelligent controller such fuzzy controller, neuro controller and evolutionary controllers.

Mapping COs/Bloom's Taxonomy Level (BLs)				
COs	CO1	CO2	CO3	CO4
BLs	BL2	BL6	BL5	BL6

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	Programme Outcomes (POs)											PSO1	PSO2
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		
CO1	3	1	2	-	1	2	2	2	2	2	2	2	1
CO2	3	3	2	3	3	3	1	-	2	3	3	3	1
CO3	3	3	3	3	2	2	2	2	3	1	3	3	3
CO4	3	3	3	3	3	3	2	1	3	3	3	3	2

Unit I

Artificial Neural Networks Applications to System Identification & Control: Introduction, learning with ANNs, single-layer networks, multi-layer perceptron's, ANNs for identification, ANNs for control. (12 Hrs)

Fuzzy Logic Control: Introduction, fuzzy sets, fuzzy logic, fuzzy logic controller design, Fuzzy Modelling & identification, Adaptive Fuzzy Control Design, Parametric optimization of fuzzy logic controller using genetic algorithm. (12 Hrs)

Unit II

Evolutionary Computation for Control & identification: Applications of EC methods to system identification and control. Combination of Soft Computation Approaches. (12 Hrs)

Control & Identification: System identification using Neuro-fuzzy, evolutionary neuro and evolutionary fuzzy systems. Lyapunov stability theory and Passivity Theory. (12 Hrs)

Recommended Books:

Textbooks:

1. R. Jang, Soft Computing, PHI
2. D. Driankov, H. Hellendoorn and M. Reinfrank, Introduction to Fuzzy Control, Springer-Verlag, 2001.

Reference Books:

1. K. Passino, Biomimicry for Optimization, Control, and Automation, Springer-Verlag, London, UK, 2005.
2. S. P. and C. H. Barratt, Linear Controller Designs-Limits of Performance, 5th edition, Prentice Hall International, 1991.

SLIET LONGOWAL

1.2.3 -INSTRUMENTATION AND CONTROL ENGINEERING (PG-ICE)

PEIE-822E MACHINE LEARNING – AN APPROACH TO ARTIFICIAL INTELLIGENCE

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: **Describe** the fundamental theory and concepts of machine learning and artificial intelligence algorithms.

CO2: **Construct** artificial neural networks, neuro-modeling, and their applications to pattern recognition.

CO3: **Assess** the learning paradigms of supervised and unsupervised shallow/deep neural networks.

CO4: **Apply** tensor flow software for real-world applications of machine learning algorithms

Mapping COs/Bloom's Taxonomy Level (BLs)				
COs	**CO1**	**CO2**	**CO3**	**CO4**
BLs	BL2	BL6	BL5	BL3

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	**Programme Outcomes (POs)**												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	1	-	-	1	-	1	3	-	1	1	1
CO2	3	3	3	3	3	3	1	-	2	3	3	3	1
CO3	3	3	3	3	2	2	2	2	3	1	3	3	3
CO4	3	3	3	3	3	3	2	1	3	3	3	3	2

Unit I

Foundations of Machine Learning I: Supervised and unsupervised learning, parametric vs non-parametric models, parametric models for classification and regression- Linear Regression, Logistic Regression, Naïve Bayes classifier, simple non-parametric classifier-K-nearest neighbour, support vector machines. Clustering- distance based- K-means, density based, association rule mining, validation techniques-cross validations, feature selection and dimensionality reduction, principal component analysis-Eigenvalues, Eigen vectors, Orthogonality- challenges motivating deep learning. (08 Hrs)

Neural Networks for Classification and Regression: ANN as a technique for regression and classification, structure of an artificial neuron, activation functions- linear activation, sigmoid and softmax. Feedforward neural networks- shallow model- single layer perceptron, multi-layer perceptron as complex decision classifier- learning XOR-Gradient based learning, Backpropagation algorithm, risk minimization, loss function, regularization, heuristics for faster training and avoiding local minima. (8Hrs)

Deep Feedforward Neural Networks: Feed forward neural networks- deep model- output units and hidden units, training deep models- hyper parameters and validation sets-cross validation, capacity, overfitting and under fitting, bias vs variance trade off, cross validation - vanishing gradient problem, new optimization methods (adagrad, adadelta, rmsprop, adam), regularization methods (dropout, batch normalization, dataset augmentation), early stopping. (08 Hrs)

Unit II

Convolutional Neural Networks: Convolution operation- kernel and feature map, sparse connectivity, equivariance through parameter sharing, pooling function for invariant representation, convolution and pooling as strong prior, convolution with stride, effect of zero padding, single-channel and multi-channel data types used in ConvNet, variants of basic convolution- locally connected, tiled ConvNet- spatial separable and depthwise separable convolutions, fully connected layers, ConvNet architecture- layer patterns, layer sizing parameters,case studies- LeNet, AlexNet. (8Hrs)

Recurrent Neural Networks: Sequence learning with neural nets, unrolling the recurrence, training RNN- Backpropagation through time (BPTT), vanishing gradient problem, Gated recurrent unit (GRU), Long short term. (6Hrs)

Deep Learning Tools and Applications : Tools:TensorFlow, Keras, PyTorch, Caffe, Theano, MXNet. Applications: Object detection with RCNN – YOLO, SSD. Speech recognition with RNN. (10Hrs)

Recommended Books:

Text Book(s)

1. B. Yoshua, I. J. Goodfellow, and Aaron Courville, Deep learning, 2015, MIT Press
2. J. Patterson and A. Gibson, Deep Learning- A Practitioner's Approach, O'Reilly Media Inc., 2017, USA.
3. O. Campesato, Artificial Intelligence, Machine Learning, and Deep Learning, Mercury Learning & Information, 2020

Reference Book(s)

1. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2011.
2. E. Rich and K. Knight, Artificial Intelligence, 2011, 2nd ed., TMH, New Delhi.
3. B. Yoshua, Learning deep architectures for AI- Foundations and trends in Machine Learning, 2(1)- 2009.
4. T. M. Mitchell, Machine Learning, McGraw-Hill Education (India) Pvt Ltd, 2013.

SLIET LONGOWAL

1.2.3 -INSTRUMENTATION AND CONTROL ENGINEERING (PG-ICE)

ACIE-821 AUDIT COURSE 2 (CONSTITUTION OF INDIA)

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successfully completing the course, students will be able to know about:

CO 1: Basic information about Indian constitution.

CO 2: Various organization of the governance.

CO 3: History & formation of Indian Constitution.

CO 4: Knowledge about Indian Judiciary.

CO 5: Knowledge About the constitutional body like election commission and its functioning.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1				3									
CO2					3								
CO3								3					
CO4						3							
CO5							3						

Unit- I

History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working).

Philosophy of the Indian Constitution: Preamble, Salient Features.

Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties. (16Hrs)

Unit-II

Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions. (14Hrs)

Unit- III

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Panchayati raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO Zila Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy. (12Hrs)

Unit- IV

Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women. (14Hrs)

Recommended Books:

Text Book(s)

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. S. N. Busi, B. R. Ambedkar, Framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D. D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

SLIET LONGOWAL

1.2.3 -INSTRUMENTATION AND CONTROL ENGINEERING (PG-ICE)

PCIE-823 ADVANCED BIO-MEDICAL INSTRUMENTATION LAB

L	T	P	Credits	Weekly Load
0	0	4	2	4

Course Outcomes:

After successful completion of course, the students should be able to

CO1: **Apply** the knowledge observe neuronal, cardiovascular and respiratory system.

CO2: Axpress working principle of different type of electrodes for biomedical application.

CO3: Axplain neuromuscular system, generation and sources of brain potential.

CO4: Justify the need and importance of telemedicine in patient monitoring system.

CO5: Analyze electro-retinogram (ERG), electro-occulogram (EOG) and sources of noise in bioelectrical signal recording.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL3	BL6	BL4	BL5	BL4

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	-	1	-	1	3	-	1	1	1
CO2	3	3	3	3	3	3	2	1	3	3	3	3	2
CO3	3	3	3	3	3	3	2	3	3	2	3	3	2
CO4	3	3	2	1	1	2	1	1	3	2	2	2	1
CO5	3	3	3	3	3	3	2	2	3	3	3	3	2

To understand the practicability of Biomedical Instrumentation and Telemedicine, a list of experiments is given below to be performed in the laboratory.

1. To design various types of active filters to remove noise in biomedical signals.
2. To study statistical analysis of biomedical signals.
3. To measure pulse rate using a pulse rate monitor.
4. To study thermal conductivity type sensors used in biomedical systems.
5. To study the health of lungs with the help of spirometer.
6. To analyze the rest ECG and moment ECG on a TMT machine.
7. To study the spectral characteristics of EEG signal.
8. To Compare the EMG signal obtained from unipolar electrodes.
9. To study QRS detection circuit and find out heart rate using R-R interval.
10. To find the effect of noise on ECG signal.

Recommended Books:

Text Books:

1. R. S. Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw-Hill
2. W. J. Tompkins and W. T. Webster, Design of Microprocessor based medical instrumentation, Englewood Cliffs.

Reference Books:

1. J. D. Bronzino, The Biomedical Engineering Handbook, 2nd Sub edition, CRC Press, 1999.
2. T. Togawa and T. Tamura, Biomedical Transducers and Instruments, CRC Press, 1997.

SLIET LONGOWAL

1.2.3 -INSTRUMENTATION AND CONTROL ENGINEERING (PG-ICE)

PCIE-824 MODELLING AND SIMULATION LAB-II

L	T	P	Credits	Weekly Load
0	0	4	2	4

Course Outcomes:

After successful completion of course, the students should be able to

CO1: **Illustrate** the knowledge of simulation concepts.

CO2: **Judge** the transient behavior of basic signals used in electrical and instrumentation engineering.

CO3: Formulate the simulation of engineering problems related to electrical, control, and instrumentation engineering.

CO4: **justify** the need for and importance of simulation and modelling.

Mapping COs/Bloom's Taxonomy Level (BLs)				
COs	CO1	CO2	CO3	CO4
BLs	BL4	BL5	BL6	BL6

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	-	1	-	1	3	-	1	1	1
CO2	3	3	3	3	3	3	2	1	3	3	3	3	2
CO3	3	3	3	3	3	3	2	3	3	2	3	3	2
CO4	3	3	2	1	1	2	1	1	3	2	2	2	1

List of experiments is given below to be performed in the laboratory.

1. Simulation of Transient response of RLC Circuit To an input (i) step (ii) pulse and(iii) Sinusoidal signals.
2. Analysis of Three Phase Circuit representing the generator transmission line and load. plot three phase currents and neutral currents.
3. Simulation of Single-Phase full converter using RLE loads and single-phase AC Voltage Controller using RL loads.
4. Plotting of Bode plots, Root Locus and Nyquist plots for the transfer functions of systems up to 5th order.
5. Power System load flow using Newton-Raphson Technique.
6. Modeling of Transformer and simulation of lossy transmission line.
7. Integrator and Differentiator circuits using OP-AMP.
8. Simulation of DC separately excited motor using Transfer function approach.
9. Simulation of Buck & Boost converters.
10. Simulation of single-Phase Inverter with PWM control.

Recommended Books:

Text Books:

1. B. P. Zeigler, H. Praehofer and I. G. Kim, Theory of modeling and simulation, 2 nd Edition. Academic press 2000
2. K Ogata, Modern control Engineering, 3 rd edition,Prentice Hall of India 2001.

Reference Books

1. J. S. R. Jang, C. T sun and E. Mizutani, Neuro-Fuzzy and soft Computing, 3rd edition, Prentice hall of India 2002
2. R. E. Shannon, System Simulation: The Art and Science, Prentice Hall Inc. 1990.
3. R Pratab,Getting started with MATLAB, Oxford university Press 2009.

SLIET LONGOWAL

1.2.3 -INSTRUMENTATION AND CONTROL ENGINEERING (PG-ICE)

PCIE-825 SEMINAR

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Explain their work effectively through writing and presentation.
CO2: Propose research based knowledge in the latest area of technology.
CO3: Persuade independent and life-long learning
CO4: Assess the project requiring individual skills.

Mapping COs/Bloom's Taxonomy Level (BLs)				
COs	**CO1**	**CO2**	**CO3**	**CO4**
BLs	BL2	BL6	BL5	BL5

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	**Programme Outcomes (POs)**												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	3	2	-	1	2	1	1	3	2	2	2	1
CO2	3	3	3	3	3	3	1	-	2	3	3	3	1
CO3	3	3	3	2	2	2	2	2	3	1	3	2	3
CO4	3	3	3	3	3	3	2	1	3	3	3	3	2

Objectives of the programme is to

1. Familiarize the students with the outside professional environment.
2. Make the students able to use the resources for the given problem/assignment.
3. Update the students with modern trends of electrical engineering.
4. Develop own opinions, particularly on issues, based on critical and reasonable approach to the information available.
5. Make the students able to present work in written, oral or formal presentation formats.

PEIE-911A MICROPROCESSOR APPLICATIONS IN INSTRUMENTATION

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: **Enumerate** evolution of 8086 microprocessor architecture & types of microprocessors.
CO2: **Create** assembly language programs of 8086 microprocessor.
CO3: **Analyze** the details of subroutines and addressing techniques of 8086 microprocessor.
CO4: **Assemble** interfacing of 8086 microprocessor with various peripheral devices.
CO5: **Summarize** application of 8086 microprocessor in various areas.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL6	BL4	BL6	BL5

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	1	1	1	2	1	1	3	2	2	2	1
CO2	3	3	3	3	3	3	1	-	2	3	3	3	2
CO3	3	3	3	-	2	2	2	2	3	1	3	2	3
CO4	3	3	3	3	3	3	2	-	3	3	3	3	2
CO5	3	3	2	3	1	3	2	2	3	3	3	3	2

Unit I

Architecture of Microprocessor: Introduction to evolution of microprocessors, 8086architecture; block diagram and pin configuration, comparison of 80186, 80286, 80386, 80486 and Pentium; architecture based. (12 Hrs)

Programming of 8086 Microprocessor: Assembly language programming of 8086 microprocessor, addressing techniques, subroutines, macros, co-routines, functions. (12 Hrs)

Unit II

Interfacing of 8086 Microprocessor: Interfacing with general purpose peripheral devices; 8255, 8253, 8259, 8279 and memory Disk controller, Cathode Ray Tube (CRT) controller and printer controller. (12 Hrs)

Applications of 8086 Microprocessor: Applications: stepper motor control, traffic control, DAS. (12 Hrs)

Recommended Books:

Text Books:

1. A. K. Ray & K. M. Bharchand, Advanced microprocessor and peripherals, architecture, programming and interfacing, TMH, 2007.
2. D. V. Hall, Microprocessors and Interfacing, Programming and Hardware, TMH, 1992.

Reference Books:

1. B. B. Brey, The Intel Microprocessor 8086, 80186, 80286, 80386, 80486, Pentium: architecture, programming & interfacing, PHI,2008.
2. B. Kauler, Windows Assembly Language & Systems Programming: 16-and 32-Bit Low-Level Programming for the PC and Windows, Taylor and Francis, 1997.

SLIET LONGOWAL

1.2.3 -INSTRUMENTATION AND CONTROL ENGINEERING (PG-ICE)

PEIE-911B ROBOTICS ENGINEERING

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Explain basics rules and ethics of robotics and kinematics of robotics.

CO2: Describe basics of sensors used for various robotic applications.

CO3: Evaluate the control of robots and different end effectors both mechanical and magnetic.

CO4: Design programs for robot using various programming languages.

CO5: Summarize the application of robotics in various fields and future of robotics.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
BLs	BL2	BL2	BL4	BL6	BL5

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	**Programme Outcomes (POs)**												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	3	2	1	1	2	1	1	3	2	2	2	1
CO2	3	2	1	-	-	1	-	1	3	2	2	2	1
CO3	3	3	3	3	3	2	2	2	3	1	3	3	3
CO4	3	3	3	3	3	3	2	1	3	3	3	3	2
CO5	3	3	2	3	1	3	2	2	3	3	3	3	2

Unit I

Introduction: Basic concepts, Robot anatomy, Robot configurations, Basic Robot motions, Types of drives, manipulator end effectors, controller, power unit. (06 Hrs)

Transformations and Kinematics: Vector operations, Translational transformations and Rotational transformations, Properties of transformation matrices, Homogeneous transformations and Manipulator, Forward solution, Inverse solution. (06 Hrs)

Sensory Devices: Non optical and optical Position sensors, Range, Proximity, touch, slip, Machine vision, Image components, Representation, Hardware, picture coding, object recognition and categorization, software consideration. (12 Hrs)

Unit II

Controls and End Effectors: Control system concepts, Analysis, control of joints, adaptive and optimal control, End effectors, classification, Mechanical, Magnetic, Vacuum, Adhesive, Drive systems, Force analysis and gripper design. (12 Hrs)

Robot Programming: Methods, Languages, types of programming, Robotic programming languages. (06 Hrs)

Robot Applications: Applications of robotics in material handling, machine loading and unloading, processing applications, welding and painting assembly and inspection, future robotic applications and related technologies developments. (06 Hrs)

Recommended Books:

Text Books:

1. R. D. Klafter, T. A. Chmielewski and M. Negin, Robot Engineering an Integrated Approach, Prentice Hall, 2009.
2. Y. Koren, Robotics for Engineering, McGraw-Hill, 1985.

Reference Books:

1. M. P Groover & N. G Odrey, M. Weiss, R. N Nagel, A. Dutta, Industrial Robotics, Technology programming and Applications, McGraw Hill, 2012.
2. J. J. Craig, Introduction to Robotics Mechanics and Control, Addison-Wesley, 1999.

SLIET LONGOWAL

1.2.3 -INSTRUMENTATION AND CONTROL ENGINEERING (PG-ICE)

PEIE-911C OPTO-ELECTRONICS AND INSTRUMENTATION

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Recall the fundamental properties of light and basics of optical components.

CO2: Categorize the different applications of laser and fiber optics.

CO3: Correlate the characteristics, design architectures and trade-offs of semiconductor lasers.

CO4: Assess architectures and trade-offs of optical detectors and modulators of light.

CO5: Describe fundamental theory of fiber optics and holography.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
BLs	BL1	BL4	BL4	BL5	BL1

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	**Programme Outcomes (POs)**												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	3	2	1	1	2	1	1	3	2	2	2	1
CO2	3	3	3	3	-	3	1	-	2	3	3	3	1
CO3	3	3	3	3	2	2	2	2	3	1	3	3	3
CO4	3	3	2	3	3	3	2	-	3	3	3	3	2
CO5	3	3	2	3	1	3	2	2	3	3	3	3	2

Unit I

Introduction: Ray theory of transmission, total internal reflection, electromagnetic mode theory of optical propagation, Fiber types, Step & Graded index fiber structure, propagation of light through fiber. (06 Hrs)

Transmission characteristics of optical fiber: signal attenuation and signal distortion in optical wave-guides, optimal design of single mode fibers, fiber bend loss, dispersion, intermodal dispersion, dispersion modified single mode fiber, polarization, nonlinear phenomena. (06 Hrs)

Optical Sources: Characteristics of Lasers, Einstein's equations, population inversion two, three and four level system. Laser rate equation, laser diode structures radiation pattern, modes, and single mode lasers, modulation of laser diodes & temperature effects, noises in laser diodes. Light-emitting diode (LEDs) - structures, materials, internal quantum efficiency, modulation capability, transient response & power bandwidth product. (08 Hrs)

Unit II

Photo Detectors: optical detector principles, absorption, quantum efficiency, responsively, photo diodes, modulation. pin photo detectors, avalanche photo diodes, CCDs, photomultiplier tube, photo detector noise, detector response time, avalanche multiplication theory and noise,. Solar cell materials and their properties, solar cell parameters, optical losses; electrical losses, surface recombination velocity. (08 Hrs)

Applications of Fiber optic and Lasers: Fiber optic sensors for common industrial parameters - V, I, pressure, and temperature. Fiber optic gyroscope. Laser based measurement of distance and length, velocity, acceleration, atmospheric effects, pollutants. Laser heating, melting, scribing, splicing, welding and trimming of materials, removal and vaporization. (08 Hrs)

Holography: Principle of holography, theory, requirements and applications. (04 Hrs)

Recommended Books:

Text Books:

1. J. M. Senior, Optical fiber Communications Principles and Practice , PHI publication, 2nd ed., 2008.
2. A. K. Ghatak and K. Thyagarajan, Optical Electronics, Cambridge University Press, 1989.
3. J. Wilson and J. F. B. Hawkes, Opto-Electronics: An Introduction, Third Edition, Pearson Education, 1998.
4. J. Ready, Industrial Applications of Lasers, Second Edition, Academic Press, 1997.

Reference Books:

1. J. Gowar, Optical Electronics, Prentice Hall, 1993.
2. G. E. Keiser, Optical Fibre Communication, McGraw-Hill, 2008.

SLIET LONGOWAL

1.2.3 -INSTRUMENTATION AND CONTROL ENGINEERING (PG-ICE)

PEIE-911D SYSTEM IDENTIFICATION AND PARAMETER ESTIMATION

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: **Develop** concepts and methodologies for parameter identification tools.

CO2: **Estimate** parameters various parameter estimation methods and algorithms.

CO3: **Compare** multivariable systems (MVS) and closed loop systems.

CO4: **Recognize** the model structure, models, order selection, validation and experiment design.

Mapping COs/Bloom's Taxonomy Level (BLs)				
COs	**CO1**	**CO2**	**CO3**	**CO4**
BLs	BL3	BL4	BL5	BL6

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	**Programme Outcomes (POs)**												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	3	2	1	1	2	1	1	3	2	2	2	1
CO2	3	3	3	2	3	3	1	-	2	3	3	3	1
CO3	3	3	3	3	2	2	2	2	3	1	3	3	3
CO4	3	3	3	3	3	3	2	1	3	3	3	3	2

Unit I

Principles of Modelling and Transfer function identification: System Identification and Stochastic Modeling- Structure and parameter estimation, Properties of estimates - validation of models-impulse Response. Step Response. Frequency response- transfer function from these.- disturbances and transfer function, State Space Models- Distributed parameter models- model structures, Identifiably of model structures. Signal spectra, Signal realization and ergodicity. Multivariable systems, Transfer functions from frequency response, Fourier Analysis and Spectral analysis- Estimating Disturbance Spectrum, Correlation Identification, Practical Implementation, Pseudo random binary signals, Maximum length sequences, Generation using hardware, random number generation on digital computer. (12 Hrs)

Parameter Estimation Methods: Guiding principles behind parameter estimation methods, Minimizing prediction errors, Linear regression and least squares methods, Statistical framework for parameter estimation, Maximum likelihood estimation, Correlating prediction errors with past data, Instrumental variable method, Consistency and identifiably- Recursive methods, RLS Algorithm, Recursive IV Method- Recursive Prediction Error Method, Recursive pseudo-linear regressions, choice of updating step. (12 Hrs)

Unit II

Identification of Multivariable Systems (MVS) and Closed Loop Systems: Transfer function matrix representation of MVS- state space method input output difference equation method -

canonical models for MVS, Comparison of different models, Identification of continuous MV systems from input output data, Identification of closed loop systems, Reduction of higher order systems, Aggregation method, Aggregation with partial realization, Singular perturbation method, Optimum approximation, comparison of different methods of model reduction. (12 Hrs)

Experiment Design and Choice of Identification Criterion: Optimal Input design, Persistently exciting condition, Optimal input design for higher order black box models, Choice of sampling interval and pre-sampling filters, Choices of Identification criterion, Choice of norm, variance: optimal instruments. (12 Hrs)

RECOMMENDED BOOKS:

Text Books:

1. T. Kailath, Linear Estimation, Prentice Hall, 2000.
2. H. W. Sorensen, Parameter Estimation: Principles and Problems (Control and Systems Theory), vol. 9, Marcel Dekker Inc., 1980.

Reference Books:

1. D. Graupe, Identification of Systems, Van Nostrand.
2. L. Ljung, System Identification Theory for the User, Prentice Hall Information, Systems Science Series.

SLIET LONGOWAL

1.2.3 -INSTRUMENTATION AND CONTROL ENGINEERING (PG-ICE)

PEIE-911E ARTIFICIAL INTELLIGENCE IN MEDICAL DIAGNOSIS

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: **Illustrate** the basics of Artificial Intelligence (AI) and human intelligence.

CO2: **Analyze** regression and clustering algorithms on medical diagnosis data and case studies.

CO3: **Simulate** supervised, unsupervised and bio-inspired AI techniques for dimension reduction or feature identification of medical diagnosis data.

CO4: **Assess** the AI algorithms for disease diagnosis and health care.

CO5: **Tabulate** the various ethical, legal, and social issues of AI in medicine.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
BLs	BL2	BL4	BL6	BL5	BL1

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	**Programme Outcomes (POs)**												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	3	1	-	-	1	-	1	3	-	1	1	1
CO2	3	3	3	3	3	3	1	3	2	3	3	3	2
CO3	3	3	3	3	2	2	2	2	3	1	3	3	3
CO4	3	3	3	3	3	3	2	1	3	3	3	3	2
CO5	3	3	2	3	1	3	2	2	3	3	3	3	2

Unit-1

Introduction to Human and Artificial Intelligence: Terminologies, Computational models of intelligence; Conceptual frameworks cognitive, neuroscience, and information theory; philosophical foundations of AI Review of relevant mathematical and statistical concepts. (4 Hrs)

Algorithms: Classification Algorithms: Naive Bayes, Decision Tree, Random Forest, Support Vector Machines, K Nearest Neighbours. Regression Algorithms: Linear regression, Logistic Regression, Multivariate Regression, Multiple Regression Algorithm. Clustering Algorithms: K-Means Clustering, Fuzzy C-means Algorithm, Expectation- Maximisation (EM) Algorithm and Hierarchical Clustering Algorithm. (10 Hrs)

Forms of Artificial Intelligence Learning: Supervised Learning: (a) Decision trees, non-parametric methods for learning, support vector machines, (b) Bio-inspired Learning (from perceptron to deep learning): neural basis of computing, classical neural networks, deep neural networks, deep belief networks, recurrent neural networks, and Convolutional Neural Networks. Unsupervised Learning:

basic and advanced clustering techniques, dimensionality reduction (feature selection and feature extraction).Knowledge Representation and Reasoning: Prepositional logic, first-order logic, ontological engineering, probabilistic reasoning. (10 Hrs)

Unit-2

Applications of Artificial Intelligence in disease diagnosis: Cardiology and Heart Disease Diagnosis, Analysis of Electromyography Signals, Electroencephalogram Analysis, Gait and Movement Pattern Analysis, Cancer Prediction Using an Enhanced Artificial Neural Network–Based Classifier. (10 Hrs)

Applications of Artificial Intelligence in Health Care: Approach for Medical Decision Support, Patient Care and Treatment, Deep Learning Oriented Robotics for Biomedical, Comparison of AI with Traditional Solutions for Biomedical. (10 Hrs)

Implementation and Evaluation: Model evaluation and performance metrics, cross-validation, model interpretability, Ethics of AI: bias, fairness, accountability, and transparency in machine learning; Ethical, Legal, and Social Issues of AI in medicine and healthcare. (4 Hrs)

Recommended Books:

1. A. Agah, Medical Applications of Artificial Intelligence, CRC Press, 2013.
2. U. Kose, O. Deperlioglu, D. J. Hemanth, Deep Learning for Biomedical Applications,CRC Press, 2021.
3. R. Begg, T. H. Lai, M. Palaniswami, Computational Intelligence in Biomedical Engineering, CRC Press, 2008.

SLIET LONGOWAL

1.2.3 -INSTRUMENTATION AND CONTROL ENGINEERING (PG-ICE)

OEIE-911A MICROCONTROLLERS AND EMBEDDED SYSTEMS

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: **Illustrate** microprocessor, micro-controllers and 8051 micro-controller architecture.

CO2: **Create** basic assembly language programs for different applications based on the understanding of the basic programming.

CO3: **Generalize** the design of 8051 microcontroller, memory details, subroutines and serial data for different applications.

CO4: **Simulate** microcontroller programs using modern simulators.

CO5: **Develop** practical design of embedded systems using programmable logic device(PLD), FPGA architecture etc.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL6	BL2	BL6	BL6

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	1	-	-	1	-	1	3	-	1	1	1
CO2	3	3	3	3	3	3	2	3	3	2	3	3	2
CO3	3	3	3	3	3	3	2	3	3	2	3	3	2
CO4	3	3	3	3	3	3	2	3	3	2	3	3	2
CO5	3	3	3	3	3	3	2	3	3	2	3	3	2

Unit I

Introduction: Microprocessor, Micro-controllers and their comparison. (06 Hrs)

The 8051 Architecture: Introduction, 8051 microcontroller hardware, input/ output, pins,ports and circuits, external memory, counters and timers, serial data input/ output, interrupts. (06 Hrs)

8051 Assembly Language Programming: The mechanics of programming, assembly language programming process, programming tools and techniques, instruction set (data moving, logical operations, arithmetic operations jump and call instructions). (12 Hrs)

Unit II

8051 Microcontroller Design: Micro-controller specification, external memory and memory space decoding, reset and clock circuits, expanding I/O, memory mapped I/O, memory address decoding, memory access times, testing the design, timing subroutines, lookup tables for the 8051, serial data transmission. (12 Hrs)

Microcontroller Applications: Interfacing keyboards, displays, Digital to Analog (D/A) and Analog to Digital (A/D), multipleinterrupts,serial data communications, introduction to the use of assemblers and simulators. (06 Hrs)

Embedded Systems: Introduction to programmable logic device (PLDs) and field-programmable gate array(FPGA) - architecture, technology and design issues, implementation of 8051 core. (06 Hrs)

Recommended Books:

Text Books:

1. J. B. Peatman, Design with Microcontroller, Prentice Hall, 1997.
2. K. J. Ayola, The 8051 Micro Controller- Architecture, Programming and Application, 2nd edition, Thomson Delmar Learning, 1996.

Reference Books:

1. A. K. Ray and K. M. Bhurchandi, Advanced Microprocessors & Peripherals: Architecture, Programming & Interfacing, TMH, 2006.
2. M. A. Mazidi and J. G. Mazidi, The 8051 Micro-controller & Embedded system, Pearson Education, 2007.
3. V. Udayashankara and M. S. Mallikarjunaswamy, 8051-Microcontroller: Hardware, Software and Applications, 1st edition, Tata McGraw Hill, Pvt. Ltd. New Delhi, 2009.

SLIET LONGOWAL

1.2.3 -INSTRUMENTATION AND CONTROL ENGINEERING (PG-ICE)

OEIE-911B ENERGY AUDITING AND MANAGEMENT

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Describe the basic aspects of energy audit and management.

CO2: Analyze the basic energy management approach.

CO3: Employ the knowledge of energy audit and its application to the field of the various engineering related problems.

CO4: Apply various data gathering and analytical techniques of energy audit.

CO5: Prepare the energy policy planning using modern tools and implement in real life problems.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL4	BL3	BL3	BL6

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	-	1	-	1	3	-	1	1	1
CO2	3	3	3	3	3	3	2	3	3	2	3	3	2
CO3	3	3	3	3	3	3	2	1	3	3	3	3	2
CO4	3	3	3	3	3	3	2	1	3	3	3	3	2
CO5	3	3	3	3	3	3	1	-	2	3	3	3	1

Unit I

Introduction: General Philosophy and need of Energy Audit and Management. Definition and Objective of Energy Management, General Principles of Energy Management, Energy Management Skills, Energy Management Strategy. (04 Hrs)

Energy Audit: Understanding Energy Costs, Bench marking, Energy performance, Matching energy usage to requirements, maximizing system efficiency. Optimizing the input energy requirements, Fuel and Energy substitution. (04 Hrs)

Data gathering : Level of responsibilities, energy sources, control of energy and uses of energy get Facts, figures and impression about energy /fuel and system operations, Past and Present operating data, Special tests, Questionnaire for data gathering. (04 Hrs)

Analytical Techniques: Incremental cost concept, mass and energy balancing techniques, inventory of Energy inputs and rejections, Heat transfer calculations, Evaluation of Electric load characteristics, process, and energy system simulation. (06 Hrs)

Evaluation of saving opportunities: Determining the savings in INR, Noneconomic factors, Conservation opportunities, estimating cost of implementation. (03 Hrs)

Energy Audit Reporting: The plant energy study report- Importance, contents, effective organization, report writing and presentation (03 Hrs)

Unit II

Energy Policy Planning and Implementation: Force Field Analysis, Energy Policy-Purpose, Perspective, Contents and Formulation. Location of Energy Manager, Top Management Support, Managerial functions, Role and responsibilities of Energy Manager, Accountability. Motivation of employees, Requirements for Energy Action Planning, Designing, Barriers, Strategies, Marketing and Communicating Training and Planning. (10 Hrs)

Energy Balance & MIS: First law of efficiency and Second law of efficiency, Facility as an Energy system, Methods for preparing process flow, Materials and Energy Balance diagram, Identification of losses, Improvements, Energy Balance sheet and Management Information System (MIS), Energy Modeling and Optimization. (10 Hrs)

Energy Audit Instruments: Instruments for Audit and Monitoring Energy and Energy Savings, Types and Accuracy. (04 Hrs)

RECOMMENDED BOOKS:

Text Books:

1. W. R. Murphy, G. Mckay, Energy Management, Butterworths.
2. C. B.Smith, Energy Management Principles, Pergamon Press.

Reference Books:

1. CRC Handbook of Energy Efficiency, CRC Press.
2. Industrial Energy Conservation Manuals, MIT Press, Mass, 1982.
3. W. C. Turner, Energy Management Handbook, John Wiley and Sons, A Wiley Interscience Publication.

SLIET LONGOWAL

1.2.3 -INSTRUMENTATION AND CONTROL ENGINEERING (PG-ICE)

OEIE-911C VIRTUAL INSTRUMENTATION AND DATA ACQUISITION

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Paraphrase the knowledge of virtual instrumentation and measurement systems.

CO2: Apply LabVIEW software for data acquisition and system control applications.

CO3: Practice hand-on exercises with Plug-in DAQ board and devices.

CO4: Simulate programs on LabVIEW platform for implementing small projects.

CO5: Develop prototype of different applications using Virtual Instrumentation.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL3	BL3	BL3	BL6

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	-	-	1	-	1	3	-	1	1	1
CO2	3	3	3	3	3	3	2	1	3	3	3	3	2
CO3	3	3	3	3	2	2	2	2	3	3	3	3	3
CO4	3	3	3	3	3	3	2	3	3	2	3	3	2
CO5	3	3	3	3	3	3	2	3	3	2	3	3	2

Unit I

Introduction: Virtual Instrumentation—Definition, flexibility—Block diagram and Architecture of Virtual Instruments — Virtual Instruments versus Traditional Instruments — Review of LabVIEW software in virtual Instrumentation and programming techniques. (12 Hrs)

Data Acquisition in Virtual Instrumentation: A/D, D/A converters, plug-in Analog input/output cards - Digital Input/output cards, Organization of the DAQ VI system - Opto isolation - Performing analog input and analog output - Scanning multiple analog channels - Issues involved in selection of data acquisition cards - Data acquisition modules with serial communication. (12 Hrs)

Unit II

Communication Networked Modules: Introduction to PC Busses—Local busses: ISA—PCI — RS232 — RS422 — RS485 — Interface Busses — USB, PCMCIA, VXI, SCXI, PXI - Instrumentation Buses: Modbus — GPIB - Networked busses — ISO/OSI Reference model, Ethernet — TCP/IP protocols. (12 Hrs)

Real Time Control in Virtual Instrumentation and Applications: Design of ON/OFF controller, simulation of industrial instruments and systems, VI functions and objects including signal processing and analysis. Typical instruments and systems -digital storage oscilloscope, spectrum analyzer, waveform generator, Data visualization from multiple locations; Distributed monitoring and control devices. (12 Hrs)

Recommended Books:

Text Books:

1. L. K. Well and J. Travis, LabView for everyone, Prentice Hall, 1995.
2. S. Gupta and J.P. Gupta, PC interfacing for data acquisition and process control, 2nd edition,ISA,1994.

Reference Books:

1. G. W. Johnson, LabView Graphical Programming, McGraw Hill, 1997.
2. R. Jamal and H. Pichlik, LabView–applications and solutions, National Instruments Release, 1998.

SLIET LONGOWAL

1.2.3 -INSTRUMENTATION AND CONTROL ENGINEERING (PG-ICE)

OEIE-911D INDUSTRIAL SAFETY

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Enumerate the basic aspects of industrial safety.

CO2: Connect the safety standards to industries where safety is prioritized.

CO3: Generalize the basic principles of machine guarding.

CO4: Apply various analytical techniques of safety measurements in machinery of different stages of industries like welding, gas cutting, boilers etc.

CO5: Conclude about the safety of different industries by inspection and testing.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL4	BL2	BL3	BL5

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	1	1	2	1	1	3	2	2	2	1
CO2	3	3	3	3	3	3	2	1	3	3	3	3	2
CO3	3	3	1	-	-	1	-	1	3	-	1	1	1
CO4	3	3	3	3	3	3	2	1	3	3	3	3	2
CO5	3	3	3	3	2	2	2	2	3	3	3	3	1

Unit I

Safety in metal working machinery and wood working machines: General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine, and grinding machines, CNC machines, Wood working machinery, types, safety principles, electrical guards, work area, material handling, inspection, standards, and codes- saws, types, hazards. (08 Hrs)

Principles of machine guarding: Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS – guarding of hazards - point of operation protective devices, machine guarding, types, fixed guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing- guard construction- guard opening, benefits of good guarding systems. (08 Hrs)

Safety in welding and gas cutting: Gas welding and oxygen cutting, resistances welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions in

brazing, soldering and metalizing – explosive welding, selection, care and maintenance of the associated equipment and instruments – safety in generation, distribution and handling of industrial gases-color coding – flashback arrestor – leak detection-pipe line safety-storage and handling of gas cylinders. (08 Hrs)

Unit II

Safety in cold forming and hot working of metals: Cold working, power presses, point of operation safeguarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot-operated presses, power press electric controls, power press set up and die removal, inspection, and maintenance-metal sheers-press brakes. Hot working safety in forging, hot rolling mill operation, safeguards in hot rolling mills – hot bending of pipes, hazards, and control measures. Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production cleaning and finishing foundry processes. (12 Hrs)

Safety in finishing, inspection and testing: Heat treatment operations, electro plating, paint shops, sand and shot blasting, safety in inspection and testing, dynamic balancing, hydro testing, valves, boiler drums and headers, pressure vessels, air leak test, steam testing, safety in radiography, personal monitoring devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation. (12 Hrs)

Recommended Books:

Textbooks:

1. Accident Prevention Manual, NSC, Chicago, 1982.
2. Occupational safety Manual, BHEL, Trichy, 1988.
3. J. V. Grimaldi and R. H. Simonds, Safety Management, All India Travelers Book seller, New Delhi, 1989.
4. N.V. Krishnan, Safety in Industry, Jaico Publishery House, 1996.

Reference Books:

1. Indian Boiler acts and Regulations, Government of India.
2. Safety in the use of wood working machines, HMSO, UK 1992.
3. Health and Safety in welding and Allied processes, Welding Institute, UK, High Tech. Publishing Ltd., London, 1989.

SLIET LONGOWAL

1.2.3 -INSTRUMENTATION AND CONTROL ENGINEERING (PG-ICE)

OEIE-911E SOFT COMPUTING TECHNIQUES

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Describe different soft computing techniques and its applications.

CO2: Discuss soft computing techniques like fuzzy logic, artificial neural networks and genetic algorithms and its applications.

CO3: Simulate optimization problems using GAs and Evolutionary algorithms.

CO4: Analyze the results of solutions obtained using different soft computing techniques.

CO5: Apply soft computing techniques to solve problems in varieties of application domains.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL2	BL3, BL6	BL4	BL3

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	-	1	-	1	3	-	1	1	1
CO2	3	2	2	-	-	1	-	1	3	-	1	1	1
CO3	3	3	3	3	3	3	2	1	3	3	3	3	2
CO4	3	3	3	3	3	3	2	3	3	2	3	3	2
CO5	3	3	3	3	3	3	2	1	3	3	3	3	2

Unit I

Introduction to Soft Computing: Concept of computing systems, "Soft" versus "Hard" computing, Characteristics of Soft computing, Some applications of soft computing techniques. (04Hrs)

Fuzzy logic: Introduction to Fuzzy logic. Fuzzy sets and membership functions, Operations on Fuzzy sets, Fuzzy relations, rules, propositions, implications, and inferences, Defuzzification techniques, Fuzzy logic controller design, Some applications of Fuzzy logic. (10 Hrs)

Artificial Neural Networks: Biological neurons and its working, Simulation of biological neurons to problem solving, Different ANNs architectures, Training techniques for ANNs, Back Propagation Network, Applications of ANNs to solve some real-life problems. (10 Hrs)

Unit II

Genetic Algorithms: Concept of "Genetics" and "Evolution" and its application to probabilistic search techniques, Basic GA framework and different GA architectures, Encoding, Crossover, Selection, Mutation, solving single-objective optimization problems using GA. (12 Hrs)

Multi-objective Optimization Problem Solving: Concept of multi-objective optimization problems (MOOPs) and issues of solving them, Multi-Objective Evolutionary Algorithm (MOEA), Non-Pareto approaches to solve MOOPs, Pareto-based approaches to solve MOOPs, Some applications with MOEAs. (12 Hrs)

Recommended Books:

Textbooks:

1. F. Martin, M. Neill, and E. Thro, Fuzzy Logic: A Pratical approach, AP Professional, 2000.
2. S. Rajasekaran, and G. A. Vijayalakshmi Pai,Neural Networks, Fuzzy Logis and Genetic Algorithms : Synthesis, and Applications, Prentice Hall of India, 2007.
3. D. K. Pratihar, Narosa, Soft Computing, 2008.

Reference Books:

1. J. S. R. Jang, C.-T. Sun, and E. Mizutani, Neuro-Fuzzy and soft Computing, PHI Learning, 2009.
2. S. Haykin, Neural Networks and Learning Machines, 3rd Edn, PHI Learning, 2011.

SLIET LONGOWAL

1.2.3 -INSTRUMENTATION AND CONTROL ENGINEERING (PG-ICE)

OEIE-911F MEDICAL IMAGE PROCESSING

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Reproduce medical image analysis theory, techniques, analysis and applications

CO2: Develop research planning and designing skills, incorporating medical image analysis

CO3: Apply tools and techniques for image quality enhancement, thresholding and segmentation problems etc. in medical images.

CO4: Interpret the relevant medical image analysis data for research to clinical applications

CO5: Justify the application of different modern tools for the research and application in medical applications.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL3, BL6	BL3	BL3	BL6

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	1	-	-	1	-	1	3	-	1	1	1
CO2	3	3	3	3	3	3	2	1	3	3	3	3	2
CO3	3	3	3	3	3	3	2	1	3	3	3	3	2
CO4	3	3	3	3	2	2	2	2	3	3	3	3	3
CO5	3	3	3	3	3	2	2	2	3	3	3	3	3

Unit I

Medical imaging systems: X-rays based imaging systems, Gamma-rays based imaging systems, Ultrasound based imaging systems, MRI. (04 Hrs)

Digitized Image Functions: Components of an image processing system, Digital image representation, Image digitization, sampling, Quantization, color images., 2-D Convolution, Fourier transform, 2D-DFT, 2D-DCT, Haar transform. (06 Hrs)

Image Enhancement: Image enhancement in spatial domain: Point processing (Identity transformation, Image negative, Brightness and contrast modification, log transformation, Power law transformation, Spatial filtering.

Image enhancement in frequency domain: Smoothing filters, sharpening filters, Unsharp masking, High boost filtering, Homomorphic filtering, Notch filters. (06 Hrs)

Thresholding and Segmentation: Detection methods, optimal thresholding, multi-spectral thresholding. Edge based segmentation, Region based segmentation. (06 Hrs)

Unit II

Image restoration: Image degradation/ restoration model, Image noises. (04 Hrs)

Image compression: Lossless compression schemes, Lossy compression schemes, Image denoising. (04 Hrs)

Image segmentation: Edge based segmentation, Threshold based segmentation, Region based segmentation, Clustering techniques, Watershed algorithm. (08 Hrs)

Image Reconstruction: Image reconstruction from projections, Radon transform, Methods for generating projection data, Types of tomography. (04 Hrs)

Recommended Books:

Textbooks:

1. J. C Russ, The image processing handbook, CRC and IEEE press, 1999.
2. M. Sonka, V. Hlavac, Roger Boyle, Image processing, analysis and machine vision, 2nd Edition, Brooks Cole publishing Co., 1999..
3. M. A. S. Ahmed, Image Processing Theory, Algorithms and Architecture, McGraw Hill, 1994.

Reference Books:

1. J. K. Udupa and G. T. Herman, 3D imaging in medicine, 2nd Edition, CRC press, 2000.
2. C. A. Hindley, Practical image processing in C, John Wiley and Sons, 1991.
3. R. C. Gonzalez, W. Paul, Digital Image Processing, Addision Wesley, 2nd Edition, 1987.
4. A. K. Jain, Fundamental of Digital Image Processing, Prentice Hall, 2002.

SLIET LONGOWAL

1.2.3 -INSTRUMENTATION AND CONTROL ENGINEERING (PG-ICE)

OEIE-911G -SOLAR AND WIND POWER TECHNOLOGIES

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: **Explain** the non conventional energy sources especially solar and wind.

CO2: **Describe** the various energy conversion techniques in solar and wind energy.

CO3: **Anticipate** the environment and economical benefits and challenges with solar and wind power generation.

CO4: **Generalize** wind and solar energy generation scenario in India and world.

CO5: **Speculate** the viability of wind and alternative energy projects by understanding the grid compatibility and integration issues of wind and solar power plants.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL1	BL6	BL6	BL6

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	-	-	1	-	1	3	-	1	1	1
CO2	3	3	1	-	-	1	-	1	3	-	1	1	1
CO3	3	3	3	3	3	3	1	-	2	3	3	3	1
CO4	3	3	3	3	2	2	2	2	3	3	3	3	3
CO5	3	3	3	3	3	3	2	2	3	3	3	3	2

Unit I

Solar Energy-Basic Concepts: Introduction, The Sun as Source of Energy, The Earth, Sun, Earth Radiation Spectrum, Extra-terrestrial and Terrestrial Radiations, Spectral Power Distribution of Solar Radiation, Depletion of Solar Radiation, Measurement of Solar Radiation, Solar Radiation Data, Solar Time, Solar Radiation Geometry, Solar Day Length, Extra-terrestrial Radiation on Horizontal Surface, Empirical Equations for Estimating Terrestrial Solar Radiation on Horizontal Surface, Solar Radiation on Inclined Plane Surface. (08 Hrs)

Solar Thermal Systems: Introduction, Solar Collectors, Solar Water Heater, Solar Passive Space Heating and Cooling Systems, Solar Industrial Heating Systems, Solar Refrigeration and Air Conditioning Systems, Solar Cookers. (08 Hrs)

Solar Photovoltaic Systems: Introduction, Solar Cell Fundamentals, Solar Cell Characteristics, Solar Cell Classification, Solar Cell Technologies, Solar Cell, Module, and Array Construction,

Maximizing the Solar PV Output and Load Matching. Maximum Power Point Tracker. Balance of System Components, Solar PV Systems, Solar PV Applications. (08 Hrs)

Unit II

Wind Energy: Introduction, Basic Principles of Wind Energy Conversion, History of Wind Energy, Wind Energy Scenario – World and India. The Nature of the Wind, The Power in the Wind, Forces on the Blades, Wind Energy Conversion, Wind Data and Energy Estimation, Site Selection Considerations. (08 Hrs)

Wind energy systems: Environment and Economics Environmental benefits and problems of wind energy, Economics of wind energy, Factors influence the cost of energy generation, machine parameters, Life cycle cost analysis. (06 Hrs)

Basic Components of a Wind Energy Conversion (WEC) System: Classification of WEC systems, Advantages and Disadvantages of WECS, Types of Wind Machines (Wind Energy Collectors), Analysis of Aerodynamic Forces Acting on the Blade, Performance of Wind- machines, Generating Systems, Energy Storage, Applications of Wind Energy, Environmental Aspects. (08 Hrs)

Advancements in Solar and wind Technologies for Grid compatibility and integration. (02 Hrs)

Recommended Books:

Textbooks:

1. J. Earnest, Wind Power Technology, PHI Learning, New Delhi, 2014
2. C. S. Solanki, B. M. Arora, V. Juzer, M. B. Patil, Solar Photovoltaic: A Lab Training Module, Cambridge University Press, New Delhi, 2009
3. S. P. Sukhatme, J. K. Nayak, Solar Energy, Tata McGraw, New Delhi, 2010.

Reference Books:

1. J. Earnest and T. Wizelius, Wind Power Plants and Project Development, PHI Learning, New Delhi, 2011.
2. L. D. Partain, L. M. Fraas, Solar Cells and Their Applications, Wiley, 2nd Ed., New Delhi, 2010.

SLIET LONGOWAL

1.2.3 -INSTRUMENTATION AND CONTROL ENGINEERING (PG-ICE)

OEIE-911 INSTRUMENTATION IN PRECISION AGRICULTURE

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: **Discuss** the concept of precision agriculture and engineering solutions.

CO2: **Plan** investigations of complex agricultural problems in yield mapping.

CO3: **Apply** modern tools to access Global Positioning systems for precision agriculture.

CO4: **Propose** the precision agriculture techniques for achievement of sustainable development goals and for using engineering and technology in the contributions to the society.

CO5: **Integrate** the precision agricultural techniques to traditional techniques for balanced environment and sustainability.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1, BL2	BL6	BL3	BL6	BL6

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	-	1	-	1	3	-	1	1	1
CO2	3	3	3	3	3	3	2	1	3	3	3	3	2
CO3	3	3	3	3	3	3	2	1	3	3	3	3	3
CO4	3	3	3	3	3	3	2	3	3	2	3	3	2
CO5	3	3	3	3	2	2	2	2	3	3	3	3	3

Unit I

Introduction: Scope of Precision Agriculture, Terminology and definitions, Overview of precision agriculture technologies, Historic Perspectives of Precision Agriculture, Data management in precision agriculture, impacts on the environment, Applications of precision agriculture. Issues and challenges in precision agriculture. (12 Hrs.)

Global Positioning Systems: Overview of Global Positioning systems, Working of GNSS Systems, The GPS segments - the space segment, the control segment, and the user segment. Factors Influencing GPS accuracy and precision, multipath reflections, Hardware for global positioning systems, Differential correction. (12 Hrs.)

Unit II

Sensors: Sensing Platforms viz. Satellites, Unmanned Aerial Vehicles (UAV), Aerial, Proximal, Electromagnetic Spectrum, Interaction of objects with Electromagnetic radiation, Active and Passive Remote Sensing techniques, Spectral resolution, Spatial resolution, and Temporal Resolution, Soil Sensors, humidity sensors, Weather Sensors, Sensor fusion techniques, Variable rate technologies. (12 Hrs.)

Geographic Information Systems: Introduction to Geographic Information Systems (GIS), Coordinate Systems, Components of GIS, Spatial and Temporal Analysis, Yield mapping, Yield Map Interpretation, Image Classification, Multiband and hyperspectral image fusion techniques. (12 Hrs)

Recommended Books:

Textbooks:

1. D. K. Shannon, D. E. Clay, N. R. Kitchen, Precision Agriculture Basics, Print ISBN:9780891183662, Online ISBN:9780891183679, DOI:10.2134/precisionagbasics, American Society of Agronomy Crop Science Society of America Soil Science Society of America.
2. J. V. Stafford, Precision agriculture '19, 2019, eISBN: 978-90-8686-888-99, ISBN: 978-90-8686-337-2.

Reference Books:

1. S. M. Pedersen, K. M. Lind, (Eds.), Precision Agriculture: Technology and Economic Perspectives, ISBN 978-3-319-68715-5
2. A. Srinivasan, Handbook of Precision Agriculture: Principles and Applications, ISBN-13: 978-1560229551, ISBN-10: 1560229551

PCIE-911 DISSERTATION (PART -1)
AND PCIE-921 DISSERTATION (PART -2)

	L	T	P	Credits	Weekly Load
PCIE-911	**0**	**0**	**20**	**10**	**10**
PCIE-921	**0**	**0**	**32**	**16**	**16**

Course Outcomes:

After successful completion of course, the students should be able to

CO1: **Review** the available literature to finalize the research area and approach to the problem relating to the topic.

CO2: **Prepare** an action plan for conducting the investigation.

CO3: **Select** an appropriate approach for Analysis/Modeling/Simulation/Design/Problem Solving/Experiment.

CO4: **Device** the development of product/process, testing, results, conclusions and future directions.

CO5: **Prepare** a Dissertation, journal manuscript, and conference paper in the standard format.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL3	BL5	BL5	BL6

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):													
COs	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	-	1	1	-	1	1	3	2	1
CO2	3	3	3	3	3	2	2	1	3	3	3	3	2
CO3	3	3	3	3	3	2	3	2	3	3	3	3	2
CO4	3	3	3	3	3	3	2	1	3	3	3	3	3
CO5	3	3	3	3	3	3	2	1	3	3	3	3	3

The object of Dissertation is to enable the student to extend further the investigative study taken up under Instrumentation and Control Engineering, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from Institute/R&D laboratory/Industry. This is expected to provide a good training for the student(s) in research and development work and technical leadership.