M.TECH. ELECTRICAL ENGINEERING
(CONTROL SYSTEM)
SCHEME AND SYLABII
W.E.F. 2019-20

BOS 28.05.2019

DEPARTMENT OF ELECTRICAL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY, KURUKSHETRA

Program Outcomes

PO1: An ability to independently carry out research / investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report /document.

PO3: Acquire a degree of mastery in the field of control system engineering

PO4: Inculcate critical reasoning with adaptive scientific temper for sustainable development in contemporary context.

PO5: Practice professional ethics and entrepreneurial development for society benefit.

Program Educational Objectives

PEO1: Students should be competent enough to tackle problems related to their profession, be it in industry or in an academic institution in India or abroad

PEO2: Students are expected to solve Control Engineering problems and also to pursue research in the appropriate technological context

PEO3: Students should exhibit ethics, professionalism, multidisciplinary approach, entrepreneurial thinking and do effective communication in their profession

PEO4: Students should be able to work individually as well as in team and engage in life-long self-learning for a successful professional career

The process for evaluating program educational objectives is interpretive; that is, achievement of program educational objectives is inferred from achievement of program outcomes.

M.TECH. ELECTRICAL ENGINEERING
CONTROL SYSTEM
M.TECH. SCHEME (W.E.F. ACADEMIC SESSION 2019-20)

Semester I

Course No.	Course	L	T	P	Credits
MEE1C01	Linear System Theory	3	-	-	3
MEE1C03	Digital Control System	3	-	-	3
MEE1C05	Optimal Control and Applications	3	-	-	3
	Elective-I	3	-	-	3
	Elective-II	3	-	-	3
	Elective-III	3	-	-	3
MEE1L01	Modelling & Simulation LAB.	-	-	3	1
MEE1S01	Seminar	-	-	1	1
Total		18	-	4	20
Total contact hours		22			

Semester II

Course No.	Course	L	T	P	Credits
MEE1C02	Multivariable Control Systems	3	-	-	3
MEE1C04	Non-Linear and Adaptive Control	3	-	-	3
MEE1C06	Identification& Estimation	3	-	-	3
	Elective-IV	3	-	-	3
	Elective-V	3	-	-	3
	Elective-VI (Departmental/Open)	3	-	-	3
MEE1L02	Advanced Control Systems Lab	-	-	4	2
	Total	18	-	4	20
	Total contact hours	22			

Summer Vacation Academic Activity

Sr. No.	Course	L	T	P	Credits
MEE1I01#	Practical/Rural/Societal/Institute Training/Short Term Course	-	-	-	-
	Total	-	-	-	-

 # Activity will be decided and evaluated by Supervisor of Student

Semester III

Sr. No.	Course	L	T	P	Credits
MEE1D01*	Dissertation Part-I	-	-	28	14
	Total	-	-	-	14

Semester IV

Sr. No.	Course	L	T	P	Credits
MEE1D02*	Dissertation Part-II	-	-	28	14
	Total	-	-	-	14

*** Evaluation will be done as per Institute norms**

The total credits is 68

Evaluation

For Theory Courses:

	Theory Papers	**Marks**
1	Mid Semester-I Examination	15
2	Mid Semester-II Examination	15
3	Teacher's Assessment	10
4	Attendance	10
5	End semester Examination	50
Total		**100**

For Practical/Lab Courses:

1	Viva voice I &II	15+15=30
2	Practical file and Class work	20
3	Attendance	10
4	End Semester	40
Total		**100**

Dissertation Part-I

- End semester evaluation by the committee on the basis of seminar/viva voce/report submitted by the candidate -100 marks. To be completed by end of Third semester (every year)

  * Committee comprising the following members

- Head of Department or faculty nominee proposed by Head of Department

- Dissertation Supervisor (and Co-supervisor)
- One faculty member as expert preferably from the same specialization

The Dissertation Part-II

After the submission of Dissertation/Internship/project report, the final examination is to be conducted. The Dissertation Internship/ Project work part-II shall be evaluated through presentation cum viva-voce examination by a committee comprising of the following

- Head of Department or faculty nominee proposed by Head of Department
- Dissertation Supervisor (and Co-supervisor)
- One external expert appointed by the Department

The evaluation will be as per the following criterion.

a) Final Evaluation Components (Maximum 70 marks)

1) Content of Report (Maximum 40 marks)

2) Presentation (Maximum 20 marks)

3) Answer to Examiner's queries (Maximum 10 marks)

b) Marks for paper presented in Conferences organized at IITs/ NITs/ IIITs/ IISc/ IISERs

Conferences sponsored by reputed professional societies (7 marks per paper)

or

Outstanding work done during internship duly certified by industrial supervisor. (Maximum 14 marks for entire b component)

c) Marks for paper in non-paid paper in peer reviewed journals in Scopus/SCI/ SCIE

(30 marks per paper)

or

Patent Accepted (30 marks per patent)

or

M.Tech. Best Project Award given by recognized agency (30 marks)

(Maximum 30 marks for entire c component)

Final Evaluation

The final grade of the fourth semester will be evaluated based on grand total of marks (a+b+c)/100 as per the institute norms.

Note: In case, the total marks (a+b+c) exceeds 100 it will be counted as 100.

Final Grading

Marks Obtained	**Grades**
Marks ≥ 85	A+
75 ≤ Marks < 85	A
65 ≤ Marks < 75	B
50 ≤ Marks < 65	C
40 ≤ Marks < 50	D
Marks < 40	F

The students who get either E or F grades appear for the examinations again in the next odd or even semester

List of Electives to be offered by the Department in Even & Odd Semester

Odd Semester (Semester-I)

Course. No.	Course Name
MEE1E31/ MEE1O71	Intelligent Control*
MEE1E33	Control System Design
MEE1E35	Mathematical Structures in Systems and Control
MEE1E37/ MEE1O73	Reliability Engineering*
MEE1E39	Process Control
MEE1E41	Digital Signal Processing
MEE1E43/ MEE1O75	Optimization Theory*
MEE1E45	Guidance and Control
MEE1E47/ MEE1O77	Introduction to Machine Learning*
MEE1E49/ MEE1O79	Virtual Instrumentation*
MEE2C03	Power System Stability & Control

Even Semester (Semester-II)

Course. No.	Course Name
MEE1E32	Variable Structure and Sliding Mode Control
MEE1E34/ MEE1O72	Robot Dynamics and Control*
MEE1E36	Consensus and Control of Multi-Agent System
MEE1E38	Robust Control and Applications
MEE1E40/ MEE1O74	Cyber Physical Systems*
MEE1E42/ MEE1O76	Event Based Control*
MEE1E44/ MEE1O78	Mechatronics*
MEE1E46/ MEE1O80	Instrumentation in Control*
MEE2C06	Smart Grid Technology
MEE2E32	Flexible AC Transmission System
MEE2E34	Power System Automation
MEE2E36	Distributed Generation & Micro-Grids
MEE3C04	PLC and Micro Controllers
MEE3C06	Electric Vehicles

*Subjects are open electives with a condition that pre-requisite of the subject is previously studied by the student

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1C01
Course Title	:	Linear Systems Theory
Number of Credits	:	3
Course Type	:	Core

COURSE OUTCOMES:
Upon completion of the course, the students will be able to

CO1 Develop mathematical models and measures for linear time invariant systems and learn preliminary theoretical results.
CO2 Study with proof the concepts of stability, controllability, observability and their applications to minimal and balanced realizations.
CO3 Study Matrix Fraction Descriptions for multivariable systems. Carry out elementary transformation on polynomial matrices and study of Smith McMillan form.
CO4 Design state feedback control laws with development of state estimators.

CONTENTS:
Introduction to spaces, Normed spaces and Hilbert spaces, Concepts of signal and system norms, Properties of operators, Concept of boundedness, Concepts of Eigen values and Eigenvectors, Jordan Blocks and block diagonalization, Functions of a square matrix, State transition matrix.
Stability of linear systems, Bounded input bounded output stability, Asymptotic Stability, Application of Lyapunov theory for linear systems.
Establishment of the results for Controllability and Observability of linear systems with simple examples, Controllability and observability grammians, concept of duality between observability and controllability, Kalman decomposition, Hidden modes and the concepts stabilizability and detectability, Development of relations for the observers for linear systems.
Input-Output representation of linear systems, MIMO descriptions and Polynomial Fraction Description and Matrix Fraction Descriptions; Elementary transformations, column & row degrees, Smith-McMillan form, Transmission and invariant zeros, Rank properties, Singular values, SVD, Functional spaces of rational matrices RH_{inf}, Minimal and Balanced Realizations. Simulation of standard results using Matlab or SciLab.

REFERENCES:

1. W.J. Rugh, "Linear System Theory", Prentice-Hall Int. Inc. NJ, 1995.
2. T. Kailath, "Linear Systems", Prentice Hall Inc., N.J. 1980
3. F.M. Callier & C.E. Desoer, "Linear System Theory", Narosa Publications,1991.
4. C.T. Chen, "Linear System Theory & Design", Oxford University Press, 1984.
5. F. Dean. K and Chow Joe, "Feedback Control Problems using Matlab", Cengage Learning, 2009

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1C03
Course Title	:	Digital Control System.
Number of Credits	:	3
Course Type	:	Core

COURSE OUTCOMES:
Upon completion of the course, the students will be able to

CO1 Represent discrete time systems using pulse transfer function approach and state space models.
CO2 Understand the modelling aspects of digital control devices and systems.
CO3 Implement the design of digital controller via classical and state space techniques.
CO4 Realizediscrete time systems.

CONTENTS:
Preliminaries: Review of Z-transform, Representation of discrete time systems: Pulse Transfer Functions & State Space models, Issues of sampling and discretization.
Models of Digital control devices and systems: Z-domain description & digital filters.
Analysis of Discrete time systems, Controllability and Observability.
Stability analysis: Jury's Test, Routh's test.
Design of Digital controller: Classical & State-space techniques.
Realization of Discrete time controller, Quantization errors.

REFERENCES:
1. Digital Control Systems – by P.N. Paraskevopoulos, Prentice Hall, 1996,
2. Digital Control & State variable methods – by M. Gopal, TMH 1997.
3. Digital Control Systems by M. Gopal, McGraw Hill, 2003

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1C05
Course Title	:	Optimal Control and Applications
Number of Credits	:	3
Course Type	:	Core

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1 Have the understanding of the theory and applications of calculus of variation and related theoretical methodologies for trajectory optimizations.

CO2 Applications of calculus of variation and related theoretical methodologies for trajectory optimizations.

CO3 Understand the Optimality Principle and Dynamic Programming, can provide a solution approach for the Hamilton Jacobi-Bellman equation

CO4 Formulate the linear quadratic optimization problem and solution via Algebraic Riccati equation.

CONTENTS:

Introduction. Static and Dynamic optimization.

Parameter optimization. Calculus of Variations: problems of Lagrange, Mayer and Bolza. Euler-Language equation and transversality conditions, Lagrange multipliers.

Pontryagin's maximum principle; theory; application to minimum time, energy and control effort problems, and terminal control problem;

Dynamic programming: Belaman's principle of optimality, multistage decision processes. application to optimal control.;

Linear regulator problem: Matrix Riccati equation and its solution, tracking problem;return difference inequality and robustness margins, cross product terms, output feedback, Linear quadratic trackers

LQG control and separation principle, simple applications.

Multi-Objective Control and applications.

REFERENCES:

1. F.L. Lewis and V.L. Syrmos, "Optimal Control", John Wiley & Sons, NY 1995.
2. D. S. Naidu, "Optimal Control Systems", CRC Press, 2002
3. Donald Kirk, "Optimal Control Theory: An Introduction", Dover Books, 2004.
4. M. Gopal, "Modern Control System Theory", New Age International Publishers, New Delhi, 2014.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1L01
Course Title	:	Modelling & Simulation LAB.
Number of Credits	:	1
Course Type	:	Core

CO 1: Develop mathematical models of various engineering and physical systems using classical and energy approach in MATLAB Environment
CO 2: Linearization of the nonlinear system using different techniques using MATLAB
CO 3: Analyze the model from control perspective and use MATLAB software tool to demonstrate analysis.
CO 4: Design and analyze Discrete Controller and estimator in MATLAB Environment.

Faculty Instructor Shall formulate List of Practical's

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
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Course Code	:	MEE1S01
Course Title	:	Seminar
Number of Credits	:	1
Course Type	:	Core

CO1 Able to select a presentation topic of current interest in the area of systems and control.
CO2 Achieve an ability to prepare fairly good looking presentation with well-organized rich presentation material.
CO3 Ability to compose text and illustrations respecting intellectual property right.
CO4 Able to comprehend conclusion with balanced views to invite open questions from audience.

Suggested Rubrics:

1. Background Content
2. Methods
3. Presentation material
4. Illustrations (Graphs, figures, tables, flowcharts etc)
5. Presentation skills
6. Report writing on Seminar
7. Time management
8. Response to Audience Queries
9. Personality, Preparedness and Gestures

Achievements to be judged on four levels: Below Average, Average, Good and Outstanding.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1E31/ MEE1O71
Course Title	:	Intelligent Control
Number of Credits	:	3
Course Type	:	Elective / Open Elective

COURSE OUTCOMES:
Upon completion of the course, the students will be able to

CO1 Distinguish between soft computing and hard computing techniques, Understand the various configurations of intelligent control systems. Identify when and where to use intelligent control.
CO2 Understand and design fuzzy logic controllers, artificial neural networks.
CO3 Use Genetic algorithms for control optimization problems.
CO4 Use simulation tools for the design performance evaluation of control systems.

CONTENTS:
Introduction to Intelligent Control, need for intelligent control, Introduction to intelligent system modeling using Fuzzy logic.
Basic Fuzzy Logic System, Fuzzy Logic based system modeling, Fuzzy Logic based Controller Design. Theoretical and implementation issues.ANN based system modeling and controller design: theoretical and implementation issues.
Neuro fuzzy systems and their application to control of complex systems, Industrial Case studies.

REFERENCES:

1. T.J. Ross, "Fuzzy Logic Control",TM.H. Publications, 2003.
2. Drinnkov, "Fuzzy Logic Control", Narosa Publishers, 2008.
3. Simon Hekins, "Comprehensive Neural Networks", Pearson Publications, 2010.
4. J.S.R. Jang, C.T. Sun, E. Mizutani, "Neuro Fuzzy and Soft Computing", P.H.I. Publishers, 2000.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1E33
Course Title	:	Control Systems Design
Number of Credits	:	3
Course Type	:	Elective

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1 Develop mathematical models and understand the mathematical relationships between the sensitivity functions and how they govern the fundamentals in control systems.
CO2 Design pole-assignment controller and the specific design procedure.
CO3 Develop state-feedback models and design state feedback controller and state observer.
CO4 Design of Gain Scheduling Controllers and variable structural controllers.

CONTENTS:
Stability and Performance Specifications. Limits of performance. Constraints on sensitivity and complementary sensitivity. Recent issues and design trade-offs.
Review of system models. Model simplifications and associated modeling errors. Discrete time and hybrid models. Recent trends.
Design features, limitations, robustness and implementation of classical compensators and PID controllers. Integrator Wind up and Anti-wind up schemes.
Design of Linear State Feedback, compensating delays, Smith predictors, Predictive controllers, Internal Model Control,
Recent trends in design of control systems. Control design based identification of complex systems. Design exercises and case studies.

REFERENCES:

1. Goodwin, G.C. Graebe, S.F. and M.E. Salgado, “Control System Design”, PrenticeHall of India, 2001.
2. Friedland, B “Advanced Control System Design”, Prentice Hall Int. Inc. NY.1966.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1E35
Course Title	:	Mathematical Structures in Systems and Control
Number of Credits	:	3
Course Type	:	Elective

COURSE OUTCOMES:
Upon completion of the course, the students will be able to

CO1 Understand the concept of mathematical structures for systems and control – groups and vector spaces.
CO2 Understand various mathematical characteristics and operations in terms of orthogonal functions and least square approximations.
CO3 Appreciate operational methods and their piecewise constant approximations.
CO4 Develop system analysis and optimization algorithms using the concept of linear algebra and their computer implementations.

CONTENTS:
Mathematical structures for systems - groups and vector spaces; function spaces, linear vector spaces, normed spaces, inner product spaces, Banach spaces, Hilbert spaces.
Mathematical characteristics and operations; orthogonality, linear operators, different types of orthogonal functions, applications in orthogonal functions' system – BPF, WF, FT, DCT, Haar wavelet, basis functions, least square approximation of signals, piecewise constant approximation of different basis functions.
Operational methods; piecewise constant approximation of linear mathematical operators, computer implementation and computational consideration, review of linear algebraic methods, applications in system analysis and control engineering, Introduction to optimal control of linear systems using operational methods.

REFERENCES:

1. P. R. Halmos, "Finite Dimensional Vector Spaces", Springer 1984.
2. J. A. Thorpe, "Elementary Topics in Differential Geometry", Springer-Verlag 2004
3. H. T. Banks,"A functional analysis framework for modeling, estimation and control in science and engineering", Chapman and Hall/CRC Press 2012.
4. James R. Leigh,"Functional analysis and linear control theory", Academic Press, 1980.
5. K. B. Datta and B. M. Mohan, Orthogonal Functions in Systems and Control, Advanced Series in Electrical and Computer Engineering, vol. 9, World Scientific, Singapore, 1995.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1E37/ MEE1O73
Course Title	:	Reliability Engineering
Number of Credits	:	3
Course Type	:	Elective/ Open Elective

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1 To analyze the failure modes & effects, and evaluate reliability functions.

CO2 Demonstrate network modelling.

CO3 To draw reliability logic diagrams, fault trees, Markov graphs and find reliability using them.

CO4 Describe various methods to evaluate, increase and allocate and optimize reliability.

CONTENTS:

Review of basic concepts in reliability engineering, reliability function, different reliability models etc.Reliability evaluation techniques for simple and complex system: Non path set and cutest approaches, path set and cut set approaches, different reliability measures and performance indices, modeling and reliability evaluation of system subjected to common cause failures. Reliability improvement, Reliability allocation/apportionment and redundancy optimization techniques

Fault tree analysis

Maintainability Analysis: measure of system performance, types of maintenance, reliability centered maintenance, reliability and availability evaluation of engineering systems using Markov models

Reliability testing, Design for reliability and maintainability, Reliability case studies

REFERENCES:

1. M.L Shooman, “Probabilistic reliability- an engineering approach” RE Krieger Pub, 1990.
2. K.K Aggarwal, “Reliability Engineering” Springer Pub, 1993.
3. E Balaguruswamy, “Reliability Engineering” Tata McGraw hill, 2010.
4. R. RamaKumar, “Engineering Reliability” Prentice, NJ, 1993.
5. Ebeling Charles, “An Introduction to Reliability and Maintainability”, Tata McGraw Hill,2000,

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1E39
Course Title	:	Process Control
Number of Credits	:	3
Course Type	:	Elective

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1. Study and analyse the characteristics of control problems in industrial processes.

CO2. Acquire knowledge about industrial control devices and their interconnections.

CO3. Ability to design practical PID controllers for process control systems with various tuning procedures

CO4. Study and apply special control techniques in control of processes with comparisons to conventional controllers

CONTENTS:

Review of systems theory, closed and open loop response. Response to step, impulse and sinusoidal disturbances, interacting and non-interacting type of systems. Control valves, types, function, hydraulic, pneumatic actuators, solenoid, stepper motors, interconnecting process components using PLCs. Interfacing and control hardware.

Stability Analysis: Frequency response, design of control system, control modes, definition, characteristics and comparison of P, PI, PD, PID controllers. Dynamic behavior of feedback controlled process for different control modes, control system quality, IAE, ISE, IATE criterion, controller tuning and process identification, Zigler-Nichols and Cohen-Coon tuning methods, Bode-Nyquist Plots - Process modelling.

Special Control Techniques: Principle, analysis and application of, cascade, ratio, feed forward, override, split range, selective controls, computing relays, simple alarms, Smith predictor, internal model control, theoretical analysis of complex processes.

Industry grade case studies.

REFERENCES:

1. 'Process Systems analysis and Control', D.R. Coughanour, Mc.Graw Hill, II Edition, 1991.
2. 'Process Dynamics and Control', D.E.Seborg, T.F.Edger, and D.A.Millichamp, John Wiley and Sons, II Edition, 2004.
3. 'Principle and Practice of Automatic Process Control', C.A.Smith and A.B.Corripio, John Wiley and Sons, 1985.
4. 'Process control', Peter Herriot, Tata McGraw Hill.
5. 'Process Modelling Simulation and Control for Chemical Engineers', W.L.Luyben, McGraw Hill, II Edition, 1990.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)

CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1E41
Course Title	:	Digital Signal Processing
Number of Credits	:	3
Course Type	:	Elective

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1. Interpret, represent and process discrete/digital signals and systems

CO2. Understand frequency domain analysis of discrete time signals and design FIR and IIR filters.

CO3. Grasp advanced concepts of digital signal processing and their analysis.

CO4. Practical implementation issues such as computational complexity, hardware resource limitations as well as cost of DSP systems or DSP Processors.

CONTENTS:

Digital Signal Processing Applications; Filter Design, FIR & IIR Digital Filter Design, filter Fourier Transform: DFT and FFT algorithms.

Real Time Implementation: Implementation using DSP for digital filters and FFT.

Multirate DSP: The basic sample rate alteration, time – domain characterization & frequency domain characterization, Cascade equivalences, filters in sampling rate alteration systems, digital filter banks and their analysis and applications; multi-level filter banks, estimations of spectra from finite – duration observation of signals.

Linear prediction and optimum linear filters: forward and backward linear prediction, AR Lattice and ARMA lattice – ladder filters, Wieners filters for filtering on prediction.

Introduction to Digital Signal Processors, Architectures of TMS-320 series, Instruction Set, Programming and Interfacing.

REFERENCES:

1. P.P. Vaidhyanathan, Multirate systems and filter banks, Prentice Hall, 1993.
2. Emmanuel Ifeachor and Barrie Jervis, Digital Signal Processing: A Practical Approach (2nd Edition), Prentice Hall, 2004.
3. J.G Proakis and D.G Manolakis - Digital Signal Processing: Principles, Algorithms and Applications, PHI, 2004.
4. A.V. Oppehein and R.W. Schafer, Discrete time signal processing, PHI, 1992
5. Haykins, Adaptive Filter Theory, Prentice Hall, 1986
6. S. K. Mitra, Digital Signal Processing, A Computer – Based approach, Tata McGraw-Hill, 2008.
7. Reference Manual of TMS-320 Digital Signal Processor, 2007.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1E43/ MEE1O75
Course Title	:	Optimization Theory
Number of Credits	:	3
Course Type	:	Elective/ Open Elective

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1. Apply knowledge of optimization to formulate and solve Engineering problems.

CO2. Understand the different methods of optimization and be able to suggest a technique for a specific problem.

CO3. Understand optimization technique using algorithms.

CO4. Optimize with non-linear programming

CONTENTS:

Review of linear programming techniques.

Multi objective optimization, transportation and assignment problem, network techniques.

Introduction to non-linear programming- constrained and unconstrained optimization problem, Kuhn-Tucker conditions, quadratic and separable programming.

Advanced optimization techniques- particles swarm optimization, genetic algorithm

Introduction to convex optimization problems.

REFERENCES:

1. SS Rao, “optimization theory and applications”, Wiley Eastern Ltd, 1996.
2. R. Panneeselvam, “Operations research”, PHI learning pvt. Ltd, 2000.
3. Boyed and Vandenberghe, “Convex optimization”,1998
4. HamdyA.Taha, “Operational research”,1999
5. ClercM. , “Particle Swarm Optimization”, Wiley, 2003.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1E45
Course Title	:	Guidance and Control
Number of Credits	:	3
Course Type	:	Elective

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1 Develop the mathematical models of Autopilots.

CO2 Design Kalman Filters for Missiles Apply the Guidance Laws for Missiles.

CO3 Apply the methods of Inertial Navigation.

CO4 Design the Optimal Controller for Autopilots.

CONTENTS:

Fundamentals of guidance and tracking systems, Simple models of aircraft and missiles. Control requirements for guidance Systematic formulation of guidance problems, Guidance using servomechanism formulation, and pre filter design, model following, regulator redesign optimal trackers.

Introduction to filtering, nonlinear filtering, prediction and smoothing, Kalman and Extended Kalman filter.

Method of Inertial navigation, integrated navigation systems, external navigation aids.

Advanced guidance laws, Guidance laws & processing.

REFERENCES:

1. Ching F. Lin, "Modern Navigation, Guidance and control processing", Prentice Hall, 1991.
2. Chin F. Lin &Ching F. Lin, "Modern Navigation, Guidance and Control Processing", Vol. II, Prentice Hall Inc., 1996.
3. Paul Zarchan, "Tactical and Strategic Missile Guidance", Progress in Astronautics and Aeronautics, Vol. 176.
4. F.L. Lewis and V.L. Syrmos, "Optimal Control", John Wiley & Sons, 2001.
5. J.H. Blackelock, "Automatic Control of Aircrafts and Missiles", Wiley Interscience, 1991.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1E47/ MEE1O77
Course Title	:	Introduction to Machine Learning
Number of Credits	:	3
Course Type	:	Elective/ Open Elective

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1. Understand complexity of real-life problems and their solution using machine learning.

CO2. Apply linear algebra, probability and statistical concepts to machine learning problems

CO3. Design using various machine learning paradigms for various engineering problems.

CO4. Apply Machine Learning using real-world data.

CONTENTS:

Learning Machines, Data representation, structured and structured data, Forms of learning, Application areas of machine learning

Supervised Learning, Heuristic search, Metrics for assessing accuracy

Statistical Learning: Descriptive statistics, Bayesian Reasoning, Linear Regression, Least square criterion

Classification: Probabilistic classifiers and Non-probabilistic classifiers

Learning with Support Vector Machines (SVM): Linear discriminant functions, Non-linear classifier; Principal Components Analysis

Learning with Artificial Neural Networks: ANN architectures and Learning rules.

Fuzzy Inference Systems: Approximate learning, Mamdani model, Takagi-Sugeno Model

Data Clustering: Data analysis, clustering methods, k- means clustering, data transformation, Introduction to deep learning.

REFERENCES:

1. E. Alpaydin, Introduction to Machine Learning, 3rd Edition, The MIT Press, 2014
2. S. Theodoridis, Machine Learning: A Bayesian and Optimization Perspective, Academic Press, 2015
3. M. Gopal, Applied Machine Learning, McGraw Hill (India), 2018.
4. P. Jain and P. Kar, Non-convex Optimization for machine Learning, Now Foundations and Trends, 2017.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1E49/ MEE1O79
Course Title	:	Virtual Instrumentation
Number of Credits	:	3
Course Type	:	Elective/ Open Elective

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: To describe about virtual instrumentation.
CO2: Get adequate knowledge VI tool sets
CO3: To describe data acquisition
CO4: To get introduced to VI programming techniques

CONTENTS:
Virtual Instrumentation: Historical perspective, advantages, block diagram and architectureof a virtual instrument, data flow techniques, graphical programming in data flow, comparison with conventional programming. Development of virtual instrument using GUI, real time systems.
VI Programming Techniques: VIS and sub VIS, loops and charts, arrays, clusters andgraphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, instrument drivers, publishing measurement data in web.
Data Acquisition basics: Introduction to data acquisition in PC, sampling fundamentals,input/output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA, Software and Hardware installation, calibration, Resolution, Data acquisition interface requirement
Lab View hardware: VI Chassis requirement, common instrument interface: currentloop, RS232C/RS485, GPIB. Bus interfaces, GPIB, PCI Card. VI toolsets and application of Virtual Instrumentation.

REFERENCES:

1. Gary Johnson,“LABVIEW graphical programming”,Second edition, McGraw hill,NY,1997.
2. Lisa K.Wells&Jeffrey travis, “Labview for everyone”,Prentice Hall,new jersey,1997.
3. Sanjay Gupta and Joseph John, “Virtual Instrumentation using labview”,(TMH), 1996.
4. Rick Bitter, Taqimohd,MahNawrock(CRC Press) Kevin James,“LAB VIEW Advanced Programming Techniques2nd edition”, “PC Interfacing and data acquisition: Techniques for measurement, Instrumentation and Control”,newness,2000.

Second Semester

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1C02
Course Title	:	Multivariable Control System
Number of Credits	:	3
Course Type	:	Core

COURSE OUTCOMES:
Upon completion of the course, the students will be able to

CO1. Understand types of MIMO systems and models, their mathematical properties, analyse the system to relate these properties to the physical properties of the system.
CO2. Study industrial process models, typical multivariable behavior, interaction issues and decoupling solutions
CO3. Demonstrate the control design strategies and understand the purpose for specific strategy to be applied.
CO4. Design the control algorithms for MIMO systems for desired performance and stability

CONTENTS:
Introduction to Multivariable Control System, Representation of multivariable systems, review of basic properties, concept of polynomial matrices and transmission zeros, stability, controllability and observability.
Feeback control of multivariable systems, performance analysis, feedforward control, Two degree of freedom controller, Hierarchical control.
Decentralized and decoupled control of multivariable systems, pairing selection, cascade control, Design issues in state and output feedback control designs, observer based multivariable control. Discussion of issues in optimal control of multivariable systems.
Design for robustness.
Implementation issues in Multivariable control systems.

REFERENCES:

1. J M Maciejowski , 'Multivariable Feedback Design, , Wesley,1989.
2. Khaki-Sedigh, B. Moaveni "Control Configuration Selection in Multivariable Plants",SpringerVerlag 2009.
3. Pedro Albertos, Antonio Sala, Multivariable Control Systems, Springer, 2003.
4. S. Skogestad , I .Postlethwaite , 'Multivariable Feedback Control ' ,Wiley,2005.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)

CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1C04
Course Title	:	Nonlinear and Adaptive Control
Number of Credits	:	3
Course Type	:	Core

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1 Understand nonlinear behaviour via perturbation theory, phase plane trajectories and Describing functions.

CO2 Design Non- linear control systems using Feedback linearization, input-state and input-output linearization.

CO3 Study the concepts of stability, convergence and robustness issues in adaptive control.

CO4 Implement Adaptive control theory for the analysis of Nonlinear control system

CONTENTS:

Introduction to nonlinear systems and their behavior.

Analysis of nonlinear systems using perturbation theory, phase plane trajectories, Describing functions, Lyapunov& Popov's methods.

Nonlinear control design techniques; Feedback linearization, input-state and input-output linearization, design issues for MIMO nonlinear systems.

Variable structure control, sliding surface design, approximation of switching laws.

Adaptive control:

Need for adaptive control, MIT rule, Model reference and self-tuning adaptive control techniques, Auto tuning, Gain scheduling.

Stability, convergence and robustness issues in adaptive control.

Adaptive control of nonlinear systems.

Practical aspects, implementation and applications of adaptive control.

REFERENCES:

1. Slotine J.J.E and W. Li, "Applied nonlinear control", Prentice Hall Inc., 1991.
2. Mohler R.R., "Nonlinear systems: Dynamics and Control", Prentice Hall Inc., 1991.
3. M. Vidyasagar, "Nonlinear system analysis", Prentice Hall, 1993
4. Hassan K.Khalil,"Nonlinear Systems" PearsonIndia Education Pvt.Ltd. 2015
5. K.J. Astrom "Adaptive Control", Addison Wesley, 1983
6. Astrom K.J. and B. Wittenmark, "Computer Controlled Systems: Theory and Design", Prentice Hall of India, 1994.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1C06
Course Title	:	Identification & Estimation
Number of Credits	:	3
Course Type	:	Core

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1 Understand statistical properties and modelling of system with Random variables.

CO2 Identify system models using identification methods both in transfer function and state space representation.

CO3 Appreciate the need for estimators and estimation process for linear systems using different techniques.

CO4 Apply the theory learned on case studies and understand computational aspects in estimation and identification.

CONTENTS:

Review of probability theory and random processes, problem formation for identification and estimation.

Models: Review of continuous and discrete, state space and input-output, disturbance models.

Identification: Impulse response and transfer function approach (only nonparametric methods).

Parameter Estimation: Introduction,Maximum likelihood method, Mean square method, Linear regressions and least-squares methods and properties, Prediction error approach Non- recursive and recursive methods

Kalman filter, Extended Kalman Filter for nonlinear estimation, Implementation and computational issues, case studies.

REFERENCES:

1. Lennart Ljung. ”System Identification: Theory for the user”, Prentice Hall Inc, NJ 1991.
2. B.N Chatterji and K.K. Parmer, “System Identification Techniques” Oxford & IBH Pub. New Delhi. 1989.
3. A. Papoulis & S U Pillai “Probability, Random Variables and Stochastic Process” 4th edition Mc Graw Hill, 2002.
4. Arun K. Tangirala, “Principles of System Identification:Theory and Practice”, CRC Press, 2015.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1L02
Course Title	:	Advanced Control Systems Lab
Number of Credits	:	2
Course Type	:	Core

CO 1: Analyze the real-time model from control perspective and use MATLAB software tool to demonstrate analysis

CO 2: Observer Design for state and disturbance estimation in MATLAB environment for the physical systems.

CO 3: Develop an advanced controller for Robotic application in MATLAB real-time environment

CO 4: Design and analyze robust controller for uncertain real-time systems in MATLAB environment

Faculty Instructor Shall formulate List of Practical's

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1E32
Course Title	:	Variable Structure and Sliding Mode Control
Number of Credits	:	3
Course Type	:	Elective

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1. Apply the knowledge of variable structure control technique to physical systems.
CO2. Design and analyse discrete sliding mode controller for practical systems
CO3. Acquire knowledge of reduction of chattering in uncertain system
CO4. Acquire knowledge on the design of sliding surface for higher order systems considering parameter variations in the system.

CONTENTS:
Introduction of variable Structure systems (VSS), VSS to improve the response, VSS for stability, Notion of sliding mode control, Variable structure systems with sliding mode, Equivalent control for the motion of sliding mode, motion of sliding mode on sliding surface.

Design of continuous sliding mode control, stable sliding surfaces design, design of sliding mode observer, Chattering and its reduction techniques, Invariance conditions.

Discrete sliding mode control, design of uncertainty estimation using sliding mode, Design of discontinuous sliding mode control.

Design of higher order sliding mode control, twisting and super twisting algorithms, Simulation studies.

References:
1. C. Edwards, and S. K.Spurgeon, Sliding Mode Control Theory and Applications, CRC Press, U.K., 1998.
2. Y. Shtessel, C. Edwards, L. Fridman, and A. Levant, Sliding mode control and observation, Springer, New York, 2014.
3. U. Itkis, Control Systems of Variable Structure, Israel Universities Press, New York,1976.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1E34/ MEE1O72
Course Title	:	Robot Dynamics and Control
Number of Credits	:	3
Course Type	:	Elective/ Open Elective

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1: Understand the basic concept of industrial robotic Manipulator

CO2: Derive direct and inverse kinematic equations of a given robot.

CO3: Derive the dynamic equations of an industrial robot.

CO4: Develop the control algorithm necessary to run the given robot

CONTENTS:

Introduction: Definition, Motivation, Historical development, BasicStructure, Classification, Workspace, Grippers.

Robot Arm Kinematics and Dynamics: Rigid motion and frame transformation, D-Hparameters, Forward Kinematics, Inverse kinematics, Lagrange formulation of dynamics.

Trajectory generation: Cartesian Scheme, Joint space scheme

Teaching methods: Manual teaching, Lead through teaching

Control Scheme: Position Control, Force control, Hybrid position and force control, Industry Multi DOF robotic manipulator case studies.

REFERENCES:

1. J.J. Craig, "Introduction to Robotics – Mechanics A Control", Addison Wesley, 2001.
2. A.J. Koivo, "Fundamentals for Control of Robotic Manipulation", John Wiley Inc. New York, 2001.
3. Spong and Vidyasagar, "Robot Dynamics and Control", John Wiley and Sons, 2005.
4. Sciavicco&Siciliano, "Modeling and Control of Robot Manipulators", McGraw Hill International Edition, 1998.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1E36
Course Title	:	Consensus and Control of Multi-Agent Systems
Number of Credits	:	3
Course Type	:	Elective

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1. Understand and apply the background mathematical theory of matrices and graph theory to describe multi agent systems.

CO2. Recognize the need for distributed systems in place of centralized systems, and distributed computational intelligence.

CO3. Formulate the consensus problems and their solution with application to simple problems

CO4. Apply output and observer based consensus protocols on multi agent systems as well as extend robust control results to such systems with applications.

CONTENTS:

Introduction to Multi Agent Systems, Basics of Cooperative control and consensus issues.
Fundamentals of Graph Theory, Graph based models of Distributed control systems.
Optimization issues and Consensus Problems in Multi Agent Systems.
Cooperative control of Multi Agent Systems, leader-follower architecture.
Introduction to Modeling of communication channels, Modeling of Network Delays, Stability assessment under network delays. Control under Communication Constraints, Formation Control in Multi Agent Systems. Position, Displacement and Distance based formation control, robust control of linear multi-agent systems. Swarming and Flocking Collision Avoidance, Applications of NCS and MAS.

REFERENCES:

1. Zhongkui Li and Zhisheng Duan, "Cooperative Control of Multi-agent Systems: A Consensus Region Approach", CRC Press, 2015.
2. Cheng-Lin Liu and Fei Liu, "Consensus Problem of Delayed Linear Multi-agent Systems: Analysis and Design", Springer Verlag, 2017.
3. Frank L. Lewis, Hongwei Zhang, K Movric and Abhijit Das, "Cooperative Controlof Multi-Agent Systems Optimal and Adaptive Design Approaches", Springer-Verlag, 2014.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1E38
Course Title	:	Robust Control and Applications
Number of Credits	:	3
Course Type	:	Elective

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
- CO1 Answer the intricacies behind the uncertainties which otherwise seem invisible, and shall understand the importance of structured and unstructured perturbations occurring in physical processes
- CO2 Study concept of additional design freedoms and parameterization of controllers.
- CO3 Use the standard convex optimization tools e.g. Linear matrix inequalities in solving the H_2 and H_∞ problems
- CO4 Apply relaxation methods for design of complex robust control tasks.

CONTENTS:
Systematic formulation of robust control problem, Uncertainty and robustness, Effect on system stability and performance, Performance limitations
Review of measures of signals and systems, H_2 and H_∞ norm computations. Linear fractional transformations, Parameterization of stabilizing controllers
Solutions to general H_2 and H_∞ control problems, H_∞ loop shaping, and Variable structure control.
Boundary crossing theorem, Hermite Biehler Theorem, Stability ball in coefficient space, Tsykin-Polyak locus, Stability margins, Polytopic families, Interval polynomials and Kharitnov's theorem, Edge theorem, Generalized Kharitnov's Theorem, Application of parameter space results for robust control design.
Linear interval control systems, LFTs, Robust stability and performance under mixed perturbations, state space parametric perturbations and robustness analysis, robust parametric stabilization problem, Nevanlinna-Pick interpolation problem.
Robust feedback design, Loop transfer recovery, solution of matrix TA-FT=LC, observer design for robustness realization, eigen structure assignment, Fault detection, isolation and adaptive control for failure accommodation.

REFERENCES:

1. K. Zhou, J.C. Doyle and K. Glover, “Robust & Optimal Control”, Prentice Hall Inc. NY 1998.
2. C. C. Tsui, Robust Control System Design, Marcel Dekker, 2004.
3. S. P. Bhattacharya, Chapellet H. and L. H. Keel, Robust Control – The Parametric Approach, Prentice Hall Inc, 1995.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)

CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1E40/ MEE1O74
Course Title	:	Cyber Physical Systems
Number of Credits	:	3
Course Type	:	Elective/ Open Elective

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1. Appreciate the state-of-the-art developments in cyber physical systems.

CO2. Study and understand issues in modeling of continuous, discrete and hybrid cyber physical systems.

CO3. Understand observation and control issues in cyber physical systems.

CO4. Apply learned theory to modern cyber physical systems and IoTs.

CONTENTS:

Introduction to cyber physical systems, communication, computation and control
Modeling of continuous systems: actor modeling and applications
Modeling of discrete systems: finite state machine and applications
Modeling of hybrid systems: integrated methods of modeling
Characteristics of time delay systems, event triggered systems, time triggered systems, stability of such systems
Application of state feedback control, estimation based control, adaptive control to cyber physical systems
Case Studies of cyber physical systems; HVAC systems, Power systems, Manufacturing systems.

REFERENCES:

1. Edward Ashford Lee, Introduction to Embedded Systems - A Cyber-Physical Systems Approach., 2014
2. Rajeev Alur, Principles of Cyber Physical Systems, MIT press publishers 2015.
3. Danda B. Rawat, Joel Rodrigues, Ivan Stojmenovic – Cyber Physical Systems Theory and Practice, CRC press, 2015

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1E42/ MEE1O76
Course Title	:	Event Based Control
Number of Credits	:	3
Course Type	:	Elective/ Open Elective

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1:Understand broader class of system which are event based with their properties.
CO2: Develop event observer based control laws for supervision and control purpose.
CO3: Realize the event based control loops.
CO4. Study various real-life manufacturing system's case studies involving event-based control.

CONTENTS:
Introduction to Event-Based Control
Event-Based State Feedback: Control Aim, Continuous State Feedback, Event-Based State Feedback, Properties of the Event-Based State-Feedback Loop
Event Based Observer Feedback control: Control Objectives, Continuous Observer based Control, Event-Based Observer, Properties of the Event-Based Observer Feedback loop.
Event-Based Stabilization of Interconnected Systems: Control of Interconnected Systems, Distributed Realization of the Event-Based State Feedback, Decentralized Event-Based State Feedback Control. Manufacturing system case study.

REFERENCES:

1. Marek Miskowicz, Event-Based Control and Signal Processing, 1st Edition CRC Press 2017
2. Daniel Lehmann, Event Based State Feedback Control, Logos Verlag Berlin GmbH, 2011 - Technology & Engineering

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1E44/ MEE1O78
Course Title	:	Mechatronics
Number of Credits	:	3
Course Type	:	Elective/ Open Elective

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1. Develop a simulation model for simple physical systems and explain mechatronics design process

CO2. Select appropriate sensors and actuators for an engineering application

CO3. Work on real life case studies

CO4. Understand mechatronic system design using case studies and carry out monitoring and diagnostics.

CONTENTS:

Concepts and Components of a Mechatronic System Review of Analog and Digital Electronics, Microcontrollers, Mechatronic sensors and actuators and interfacing circuits.

Control Implementation: Hardware and software interfaces.

Mechatronic System Design; Monitoring and diagnosis, Case studies.

REFERENCES:

1. A Smaili and F. Mrad, "Mechatronics: Integrated Technologies for intelligent machines", Oup, New Delhi, 2008.
2. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Pearson Education, 2003
3. Mechatronics: Principles, concepts and applications, N.P. Mahalik, Tata McGraw Hill, 2010

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1E46/ MEE1O80
Course Title	:	Instrumentation in Control
Number of Credits	:	3
Course Type	:	Elective/ Open Elective

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1: Understand different types of Instrumentation Systems

CO2: Study of various types of sensors and transducers along-with compatible DAS, instrumentation and transmission sub-systems.

CO3. Understand the instrumentation design life cycle and its various steps.

CO4: Study of instrumentation system considerations in hazardous areas and concepts of safe design.

CONTENTS:

Sensors & transducers – Types, characteristics & application of transducers. Principle of different sensors, selection of sensors, smart pressure transmitters.

Analog & Digital DAS – Analog & automated DAS, Single / multi-channel DAS, Interfacing transducers to electronic control & measuring systems, multiplexing, instrument interconnection systems, data transmission protocols and standards, applications to SCADA systems.

Instrument design – Introduction, Life cycle, circuit design & layout, assembly, inspection testing & calibration. Wiring & cabling, Enclosures, grounding & shielding.

Instrumentation in hazardous areas – Introduction, Area classification, enclosures & safe designs

REFERENCES:

1. Ernest O. Doebelin,“Measurement Systems Application and Design”, T.M.H Productions, 2001.
2. J. Park, S. Mackay and E. Wright, Practical Data Communications for Instrumentation and Control, Elsevier, 2003.
3. Albert D. Helfrick & William D. Cooper, “Modern Electronic Instrumentation and Measurement Techniques, P.H.I. Productions, 1998.

Third Semester

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1D01
Course Title	:	Dissertation Part-I
Number of Credits	:	14
Course Type	:	Dissertation

Course Outcomes

CO1: Acquire an ability to search research problem of current interest
CO2: Understand research concepts and contexts clearly and effectively in oral and written manner
CO3: Ability to conceptualize research in terms of environment and society.
CO4: Understand issues related to ethics in research and publications.

Suggested Rubrics:

- Selection of Dissertation topic with objectives
- Identification of methodology to be adopted
- Complete Literature survey in proposed area
- Proposed design/setting up / simulation environment for experiment.
- Benchmarks used / Assumptions made
- Sample Simulation results towards preparedness for dissertation
- Documentation of report towards preparedness for dissertation work

Achievements to be judged on four levels: Below Average, Average, Good and Outstanding

Fourth Semester

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM W.E.F. 2019-20

Course Code	:	MEE1D02
Course Title	:	Dissertation Part-II
Number of Credits	:	14
Course Type	:	Dissertation

CO1: Achieve an ability to carry out extensive literature studies along with merits and demerits of existing research

CO2: Develop aptitude to Identify, formulate and investigate current research problem

CO3: Ability to formulate models of physics systems, analyze them and propose control solutions.

CO4: Acquire an ability to document literature surveys, research problem formulation along with analysis and design solutions.

Suggested Rubrics:

- Apparent and concise objectives
- Evident methodology articulated using technical terms indicating all steps and tools
- Cites substantial current and good quality literature
- The clarity in design/setting up of experiment.
- Benchmarks used / Assumptions made
- Interpretation of results and justification thereof and validity of the results presented
- Documentation of the work

Achievements to be judged on four levels: Below Average, Average, Good and Outstanding