PG Program [M. Tech.]

Embedded Control Systems

Curriculum Structure

w.e. f. AY 2019-20 and applicable for batches admitted from AY 2019-20 to 2022-23

Faculty Coordinator (ECS) **BOS Coordinator**

HEED

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Embedded Control Systems
Curriculum Structure
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List of Abbreviations

Abbreviation	Title	No of courses	Credits	% of Credits
PSMC	Program Specific Mathematics Course	1	3	4.4%
PSBC	Program Specific Bridge Course	1	3	4.4%
DEC	Department Elective Course	3	9	13.2%
MLC	Mandatory Learning Course	2	0	0%
PCC	Program Core Course	6	18	26.5%
LC	Laboratory Course	2	7	10.3%
IOC	Interdisciplinary Open Course	1	3	4.4%
LLC	Liberal Learning Course	1	1	1.5%
SLC	Self Learning Course	2	6	8.8%
SBC	Skill Based Course	2	18	26.5%

Semester I

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme L	T	P	Credits
1.	PSMC	ECS-19001	Mathematical Modeling& Analysis of Dynamic Systems	3	0	--	3
2.	PSBC	ECS-19002	Engineering Optimization	3	0	--	3
3.			Department Elective -I (Any one of)	3	--	--	3
	DEC	ECS(DE)-19003	Industrial Automation and Control (MOOC)				
		ECS(DE)-19001	Probability and statistics				
		ECS(DE)-19002	System Identification				
		ECS(DE)-19004	Machine learning (MOOC)				
		ECS(DE)-19013	Automotive Embedded Product Development				
4.	MLC	ML-19011	Research Methodology and Intellectual Property Rights	2	--	--	--
5.	MLC	ML-19012	Effective Technical Communication	1	--	--	--
6	PCC	ECS-19003	Digital Control System : Analysis and Design	3	0	-	3
7	PCC	ECS-19004	Embedded Systems	3	0	-	3
8	PCC	ECS-19005	Linear System Theory: Analysis and Design	3	-	-	3
9	LC	ECS-19006	Simulation Lab	-	--	4	2
10	LC	ECS-19007	Embedded Systems Lab I	-	--	4	2
			Total Credits	22			

Interdisciplinary Open Course (IOC): Every department shall offer one IOC course (in Engineering/Science/Technology). A student can opt for an IOC course offered by a department except the one offered by his /her department.

Semester II

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme L	T	P	Credits
1.	IOC	EE19004	Interdisciplinary Open Course (from other dept.) Engineering Optimization	3	--	--	3
2.	DEC		Department Elective -II	3	--	--	3
		ECS(DE)-19005	Intelligent Control				
		ECS(DE)-19006	Adaptive Control				
		ECS(DE)-19007	Sliding Mode Control				
		ECS(DE)-19008	Automotive Electronics: Hardware Development				
3.	DEC		Department Elective -III	3	--	--	3
		ECS(DE)-19009	Control Related Estimations				
		ECS(DE)-19010	Fractional Order Control				
		ECS(DE)-19011	Modeling and control of Power converters				
		ECS(DE)-19012	Automotive Electronics : Software Development				
4.	LLC	LL19004	Liberal Learning Course	--	--	--	1
5	PCC	ECS19008	Optimal Control	3	--	--	3
6	PCC	ECS19009	Nonlinear Dynamical Systems	3	---	--	3
7	PCC	ECS19010	Embedded System Design	3	--	--	3
8	LC	ECS19011	Embedded System Lab II	--	--	4	2
9	LC	ECS19012	HIL Lab	--		2	1
			Total Credits	22			

Semester-III

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	SBC	20001	Dissertation Phase – I	--	--	18	9
2.	SLC	20002	Project and Finance Management	3	--	--	3
			Total Credits				**12**

Semester-IV

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	SBC	20003	Dissertation Phase – II	--	--	18	9
2.	SLC	20004	Design of Internet of Things	3	--	--	3
			Total Credits				**12**

Programme Objectives:

i) PO1: An ability to independently carry out research /investigation and development work to solve practical problems.
ii) PO2: An ability to write and present a substantial technical report/document.
iii) PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

SEMESTER - I

[ECS-19001] Mathematical Modeling and Analysis of Dynamical Systems

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Develop mathematical models of various engineering and physical systems using classical and energy approach.
2. Demonstrate linearization techniques.
3. Analyze the model from control perspective

Syllabus contents:

Modeling by first principle approach of simple Mechanical, Electrical, Thermal, Chemical systems. Modeling by energy Approach using Lagrangian and Hamiltonian. Linearization of nonlinear models, state space approach for analyzing the dynamic models.

Modeling and Analysis of some typical systems such medical disease and treatment, Rocket Launcher, Resource Management etc., Numerical models using impulse response, step response. Several case studies (Mechanical, Thermal, Electric, etc.).

References:

1. K. Ogata, "System Dynamics", Pearson Prentice-Hall, 4th Edition, 2004.
2. M. Gopal, "Modern Control Systems Theory", 2nd Edition, John Wiley, 1993
3. E.O. Doeblin, "System Modeling and Response", John Wiley and Sons, 1980.
4. Desai and Lalwani, "Identification Techniques", Tata McGraw Hill, 1977.
5. Goldstain, "Classical Mechanics"

[ECS-19002] Engineering Optimization

Teaching Scheme:
Lectures: 3 Hrs/week

Examination Scheme:
T1, T2 – 20 marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Explain and use the basic theoretical principles of optimization and various optimization techniques.
2. Develop and select appropriate models corresponding to problem descriptions in engineering and solve them correctly.
3. Solve and analyze complex optimization problems in power system/ control system/ machine drive
4. Implement various optimization software tools to solve power system/ control system/ machine drive problems and develop algorithms to solve electrical problems.

Syllabus Contents:

Introduction to optimization, Classical Optimization: Single variable optimization, Multivariable optimization with no constraints, Multivariable optimization with equality constraints, Multivariable optimization with inequality constraints. Linear Programming: Simplex Method, Duality, Transportation problems. Nonlinear Programming: One dimensional minimization methods, unconstrained and constrained optimization.

Dynamic Programming: Development of dynamic programming, Principle of optimality. Practical Aspects of Optimization: Reduced basic techniques, Sensitivity of optimum solution to problem parameters, advanced optimization techniques, applications of optimization techniques to power system/control systems/power electronics and machine drives.

References:

1. R. Fletcher, "Practical Optimization", Second edition, John Wiley and Sons, New York, 1987.
2. S. S. Rao, "Engineering Optimization-Theory and practice", fourth edition, Wiley Easter Publications, January 2009.
3. K. V. Mital and C. Mohan, "Optimization Methods in Operations Research and System Analysis", New age International Publishers, Third edition, 1996.
4. Bazaraa M. S., Sherali H.D. and Shetty C. "Nonlinear Programming Theory and Algorithms", John Wiley and Sons, New York 1993.
5. Bertsekas D. P., "Constrained Optimization and Lagrange Multiplier Methods", Academic Press, New York, 1982.Durga Das Basu, "Introduction to the Constitution of India" Prentice Hall EEE, 19th/20th Edn., 2001. (Students Edn.)

[ML-19011] Research Methodology and Intellectual Property Rights

Teaching Scheme :
Lectures: 2 hrs/week

Evaluation Scheme :
Continuous evaluation
Assignments/Presentation/Quiz/Test

Course Outcomes (COs):

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

1. Demonstrate research problem formulation and approaches of investigation of solutions for research problems
2. Learn ethical practices to be followed in research and apply research methodology in case studies and acquire skills required for presentation of research outcomes
3. Discover how IPR is regarded as a source of national wealth and mark of an economic leadership in context of global market scenario
4. Summarize that it is an incentive for further research work and investment in R & D, leading to creation of new and better products and generation of economic and social benefits

Unit 1: [5Hrs]
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.
Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations.

Unit 2: [5Hrs]
Effective literature studies approaches, analysis. Use Design of Experiments /Taguchi Method to plan a set of experiments or simulations or build prototype. Analyze your results and draw conclusions or Build Prototype, Test and Redesign

Unit 3: [5Hrs]
Plagiarism, Research ethics, Effective technical writing, how to write report, Paper. Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 4 : [4Hrs]
Introduction to the concepts Property and Intellectual Property, Nature and Importance of Intellectual Property Rights, Objectives and Importance of understanding Intellectual Property Rights

Unit 5 : [7Hrs]
Understanding the types of Intellectual Property Rights: -Patents-Indian Patent Office and its Administration, Administration of Patent System – Patenting under Indian Patent Act , Patent Rights and its Scope, Licensing and transfer of technology, Patent information and database. Provisional and Non Provisional Patent Application and Specification, Plant Patenting, Idea Patenting,
Integrated Circuits, Industrial Designs, Trademarks (Registered and unregistered trademarks), Copyrights, Traditional Knowledge, Geographical Indications, Trade Secrets, Case Studies

Unit 6 : [4Hrs]
New Developments in IPR, Process of Patenting and Development: technological research, innovation, patenting, development, International Scenario: WIPO, TRIPs, Patenting under PCT

References:

1. Aswani Kumar Bansal, “Law of Trademarks in India”
2. B L Wadehra, “Law Relating to Patents, Trademarks, Copyright, Designs and Geographical Indications”.
3. G.V.G Krishnamurthy, “ The Law of Trademarks, Copyright, Patents and Design”.
4. Satyawrat Ponkse, “The Management of Intellectual Property”.
5. S K Roy Chaudhary & H K Saharay, “The Law of Trademarks, Copyright, Patents”
6. T. Ramappa “Intellectual Property Rights under WTO”, S. Chand.
7. Manual of Patent Office Practice and Procedure
8. WIPO : WIPO Guide To Using Patent Information
9. Halbert, “Resisting Intellectual Property” ,Taylor & Francis
10. Mayall, “Industrial Design”, Mc Graw Hill
11. Niebel , “Product Design”, Mc Graw Hill

[ML-19012] Effective Technical Communication

Teaching Scheme:
Lectures: 1hr / week

Evaluation Scheme:
100M: 4 Assignments (25M each)

Course Outcomes (COs):

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

1. Produce effective dialogue for business related situations
2. Use listening, speaking, reading and writing skills for communication purposes and attempt tasks by using functional grammar and vocabulary effectively
3. Analyze critically different concepts / principles of communication skills
4. Demonstrate productive skills and have a knack for structured conversations
5. Appreciate, analyze, evaluate business reports and research papers

Syllabus Contents:

Unit 1: Fundamentals of Communication **[4 Hrs]**
7 Cs of communication, common errors in English, enriching vocabulary, styles and registers

Unit 2: Aural-Oral Communication **[4 Hrs]**
The art of listening, stress and intonation, group discussion, oral presentation skills

Unit 3: Reading and Writing **[4 Hrs]**
Types of reading, effective writing, business correspondence, interpretation of technical reports and research papers

References:

1. Raman Sharma, “Technical Communication”, Oxford University Press.
2. Raymond Murphy “Essential English Grammar” (Elementary & Intermediate) Cambridge University Press.
3. Mark Hancock, “English Pronunciation in Use” Cambridge University Press.
4. Shirley Taylor, “Model Business Letters, Emails and Other Business Documents” (seventh edition), Prentise Hall
5. Thomas Huckin, Leslie Olsen “Technical writing and Professional Communications for Non-native speakers of English”, McGraw Hill.

[ECS-19003] Digital Control System: Analysis and Design

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Obtain discrete representation of LTI systems
2. Analyze stability of open loop and closed loop discrete system
3. Design and analyze Discrete Controller
4. Design state feedback controller and estimators

Syllabus contents:

Discrete time systems, discretization, sampling, aliasing, choice of sampling frequency, ZOH equivalent, state space models of discrete systems. Z-Transform for analyzing discrete time systems, transfer function, Internal stability, design of discrete time control using conventional methods, Stability of discrete time systems, state space analysis, pole placement and observer.

References:

1. K. Ogata, ”Discrete Time Control Systems”, Prentice hall, 1995.
2. Kuo, Benjamin C, “Digital Control Systems”, New York : Holt, Rinehart and Winston, 1980.
3. M. Gopal, “Digital Control”, McGraw Hill.
4. G. F. Franklin, J. D. Powell, M.L. Workman, “Digital Control of Dynamic Systems”, Saddison-Wesley, Reading, MA, 1998.

[ECS-19004] Embedded Systems

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 20 marks each
End-Sem Exam – 60 marks

Course Outcomes:

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

1. Deploy low end applications using low and high level languages on microcontroller platform.
2. Test and debug peripherals in embedded system.
3. Identify, design and implement applications on embedded platform.

Syllabus contents:

Introduction to Embedded System and Embedded System Design Flow. Signal Conditioning & Various Signal Chain Elements, Critical Specifications, How to smartly choose elements from wide choice available in market. Various elements include OPAMPs, Comparators, Instrumentation OP AMPs, ADCs, DACs, DC-DC Converters, Isolators, Level Shifters, ESD Protection Devices. Use Case Analysis . Systems on Chip, Memory Subsystem , Bus Structure, Interfacing Protocol, Peripheral interfacing, Testing & Debugging, Power Management, Software for Embedded Systems, Design of Analog Signal Chain from Sensor to Processor with noise, power, signal bandwidth, Accuracy Considerations. Software Programming Optimization, Concurrent Programming. Real Time Scheduling, I/O Management, Embedded Operating Systems. RTOS, Developing Embedded Systems, Building Dependable Embedded Systems.

References:

1. Steve Heath, "Embedded Systems Design", Publisher Butterworth-Heinemann.
2. Wyne Woff “Principles of Embedded computing system design”, Morgan Koffman publication 2000
3. Rajkamal, “Embedded Systems- Architecture, Programming and Design”, 2007- TMH.
4. Qing Li, “Real Time Concepts for Embedded Systems”, Elsevier, 2011.
5. Shibu K.V, “Introduction to Embedded Systems”, Mc Graw Hill.
6. Frank Vahid, Tony Givargis, “Embedded System Design”, John Wiley.
7. Lyla “Embedded Systems”, Pearson, 2013.

[ECS-19005] Linear System Theory: Analysis and Design

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Analyze linear control system using vector spaces.
2. Design linear control system using state space to achieve desired system performance
3. Design Linear quadratic regulator to achieve desired system performance

Syllabus contents:

Review of Linear Algebra : Vector space, linear combination, linear independence, bases of a vector space, representation of any vector on different basis, matrix representation of a linear operator, change of basis, rank, nullity, range space and null space of a matrix, Eigen value and Eigen vector of a matrix, similarity transform, diagonalization. Linear System analysis in state space: Controllability, Observability and Stability, Lyapunov's stability analysis of SISO and MIMO linear systems. Minimal realizations and co-prime fractions. Control Design: State feedback controller by pole placement and design of observer for linear systems Optimal Control: Formulation of optimal control problem, linear quadratic regulator (LQR), Riccati equations for control design.

References:

1. Chi-Tsong Chen, "Linear System Theory and Design", Oxford University Press.
2. John S. Bay, "Linear System Theory".
3. Thomas Kailath, "Linear System", Prentice Hall, 1990
4. Gillette, "Computer Oriented Operation Research", Mc-Graw Hill Publications.
5. K. Hoffman and R. Kunze, "Linear Algebra", Prentice-Hall (India), 1986.
6. G.H. Golub and C.F. Van Loan, "Matrix Computations", North Oxford Academic, 1983.
7. Norman Nise, "Control System Engineering", John Wiley and sons, 4^{th} Edition, 2004
8. K. Ogata, "Modern Control Theory", Prentice Hall India

[ECS-19006] Simulation Lab

Teaching Scheme:
Lectures: 4 Hrs/week

Examination Scheme:
Continuous Assessment- 50 Marks
Final Practical/Oral Exam – 50 Marks

Course Outcomes:

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

1. Demonstrate use of advanced software tools like MATLAB, PSIM for problem analyzing the system performance.
2. Simulate the dynamic system and its control
3. Analyze and interpret the result.

Syllabus contents:
Simulation experiments/assignments on the platform like MATLAB, SCILAB, ATP/EMTP, PSCAD, MAXWEL, LABVIEW etc. The problems will be related to the core subjects.

[ECS-19007] Embedded System Lab I

Teaching Scheme:
Lectures: 4 Hrs/week

Examination Scheme:
Continuous Assessment- 50 Marks
Final Practical/Oral Exam – 50 Marks

Course Outcomes:

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

1. Perceive what is a microcontroller, microcomputer, embedded system.
2. Compile different components of a micro-controller and their interactions.
3. Become familiar with programming environment used to develop embedded systems
4. Experiment with key concepts of embedded systems like I/O, timers, interrupts, interaction with peripheral devices
5. Learn debugging techniques for an embedded system

Syllabus contents:
Experiments based on above objectives such as PID control, LED Interface, timers, Design of Energy meter etc.

References:

1. Steve Heath, "Embedded Systems Design", Publisher Butterworth-Heinemann.
2. Wyne Woff "Principles of Embedded computing system design", Morgan Koffman publication 2000
3. Rajkamal, "Embedded Systems- Architecture, Programming and Design", 2007- TMH.
4. Qing Li, "Real Time Concepts for Embedded Systems", Elsevier, 2011.
5. Shibu K.V, "Introduction to Embedded Systems", Mc Graw Hill.
6. Frank Vahid, Tony Givargis, "Embedded System Design", John Wiley.
7. Lyla "Embedded Systems", Pearson, 2013.
8. MSP 430 Guide

SEMESTER - II

[EE-19004] Engineering Optimization

Teaching Scheme:
Lectures: 3 Hrs/week

Examination Scheme:
T1, T2 – 20 marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Explain and use the basic theoretical principles of optimization and various optimization techniques.
2. Develop and select appropriate models corresponding to problem descriptions in engineering and solve them correctly.
3. Solve and analyze complex optimization problems in various domains.
4. Implement various optimization software tools to solve power system/ control system/ machine drive problems and develop relevant algorithms.

Syllabus Contents:

Introduction to optimization, Classical Optimization: Single variable optimization, Multivariable optimization with no constraints, Multivariable optimization with equality constraints, Multivariable optimization with inequality constraints. Linear Programming: Simplex Method, Duality, Transportation problems. Nonlinear Programming: One dimensional minimization methods, unconstrained and constrained optimization.

Dynamic Programming: Development of dynamic programming, Principle of optimality. Practical Aspects of Optimization: Reduced basic techniques, Sensitivity of optimum solution to problem parameters, advanced optimization techniques, applications of optimization techniques to real time problems.

References:

1. R. Fletcher, "Practical Optimization", Second edition, John Wiley and Sons, New York, 1987.
2. S. S. Rao, "Engineering Optimization-Theory and practice", fourth edition, Wiley Easter Publications, January 2009.
3. K. V. Mital and C. Mohan, "Optimization Methods in Operations Research and System Analysis", New age International Publishers, Third edition, 1996.
4. Bazaraa M. S., Sherali H.D. and Shetty C. "Nonlinear Programming Theory and Algorithms", John Wiley and Sons, New York 1993.
5. Bertsekas D. P., "Constrained Optimization and Lagrange Multiplier Methods", Academic Press, New York, 1982.Durga Das Basu, "Introduction to the Constitution of India" Prentice Hall EEE, 19th/20th Edn., 2001. (Students Edn.)

[LL19004] Liberal Learning Course

Teaching Scheme:
Lectures: 0

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Demonstrate the additional information related to the area of their interest; may not be even technical, with enthusiasm.
2. Demonstrate their hidden talent in the area of their interest

[ECS19008] Optimal Control

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Analyze and synthesize optimal open loop control signals using the Maximum principle.
2. Analyze and synthesize optimal feedback laws using the Hamilton-Jacobi-Bellman equation.
3. Use numerical software to solve optimal control problems.
4. Describe the connections between optimal control and other optimization approaches.

Syllabus contents:

Introduction – Performance Index- Constraints – Formal statement of optimal control system – Calculus of variations – Function, Functional, Increment, Differential and variation and optimum of function and functional – The basic variational problem Extrema of functions and functional with conditions – variational approach to optimal control system

Linear Quadratic Optimal Control System- Problem formulation – Finite time Linear Quadratic regulator – Infinite time LQR system: Time Varying case- Time-invariant case – Stability issues of Time invariant regulator – Linear Quadratic Tracking system: Fine time case and Infinite time case

Variational calculus for Discrete time systems – Discrete time optimal control systems:-Fixed final state and open-loop optimal control and Free-final state and open-loop optimal control – Discrete time linear state regulator system – Steady state regulator system

Pontryagin Minimum Principle – Dynamic Programming:- Principle of optimality, optimal control using Dynamic Programming – Optimal Control of Continuous time and Discrete-time systems – Hamilton Jacobi-Bellman Equation – LQR system using H-J-B equation

Constrained Optimal Control Systems

Time optimal control systems – Fuel Optimal Control Systems- Energy Optimal Control Systems – Optimal Control Systems with State Constraints

Text Books:

1. Donald E. Kirk, “Optimal Control Theory – An Introduction”, Dover Publications, Inc. Mineola, New York, 2004.
2. Frank L. Lewis, DragunaVrabie, Vassilis L. Syrmos, “Optimal Control, 3rd Edition”, Wiley Publication, 2012.
3. D. Subbaram Naidu, “Optimal Control Systems”, CRC Press, New York, 2003.

References:

1. B.D.O. Anderson and J.B. Moore, “Optimal Control – Linear Quadratic Methods,” PHI, 1991.
2. S. H. Zak, “Systems and Control,” Oxford University Press, 2006.
3. R.T.Stefani, B.Shahian, C.J.Savant, J.G.H.Hosletter, “Design of Feedback Control Systems”, Oxford University Press, 2009.

[ECS19009] Nonlinear Dynamical Systems

Teaching Scheme:
Lectures: 3 hrs/week,

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Explore tools for stability analysis and response evaluation of control problems with significant nonlinearities.
2. Compute the performance and stability of the system.
3. Identify the design problem and distinguish between the controls strategies
4. Correlate between design parameters and the system performance.

Syllabus contents:
Introduction to Nonlinear Systems, Linearization, Phase Plane and Describing Function Methods for Analysis of Nonlinear Systems Lyapunov's stability: Autonomous Systems Invariance Principle, Non-Autonomous Systems. Linear Time Varying Systems, Systems Analysis based on Lyapunov's Direct Method (Krasovaskii's method, Variable Gradient Method), Converse Theorems, Centre Manifold Theorem, Region of Attraction, Stability of Perturbed System, Input to State Stability. Lyapunov like Analysis using Barbalet's Lemma, Advanced Stability Theory. Nonlinear Control Systems Design by Feedback Linearization and any other methods some design examples of nonlinear systems such as the ball and beam, flight control, magnetic levitation and robotic manipulator etc. Approximate solution of nonlinear system using the perturbation method and averaging method.

References:

1. H. K. Khalil, "Nonlinear Systems", Prentice Hall, 2001.
2. Jean-Jacques E. Slotine, Weiping Li, "Applied nonlinear Control", Prentice Hall, 1991.
3. M Vidyasagar, "Nonlinear systems Analysis", 2nd Edition, Prentice Hall, 1993.
4. Alberto Isidori, "Nonlinear Control System", Vol I and II, Springer, 1999.
5. M. Gopal, "Modern Control System"

[ECS19010] Embedded System Design

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Illustrates memory organization
2. Test and debug peripherals in embedded system
3. Elaborate RTOS
4. Design small embedded system

Syllabus contents:

Systems on chip, Memory Subsystem, Bus Structure, Interfacing Protocol, Peripheral Interfacing, Testing & Debugging, Power Management, Software for embedded Systems, Software Programming Optimization, Concurrent Programming. Real time scheduling, I/O Management, Embedded Operating Systems, Networked embedded systems. Designing Embedded Systems, Special Networking Protocols (CAN Bluetooth) Applications. Developing Embedded Systems, Building Dependable Embedded Systems.

References:

1. Steve Heath, "Embedded Systems Design", Publisher Butterworth-Heinemann.
2. Wyne Woff "Principles of Embedded computing system design", Morgan Koffman publication 2000
3. Rajkamal, "Embedded Systems- Architecture, Programming and Design", 2007- TMH.
4. Qing Li, "Real Time Concepts for Embedded Systems", Elsevier, 2011.
5. Shibu K.V, "Introduction to Embedded Systems", Mc Graw Hill.
6. Frank Vahid, Tony Givargis, "Embedded System Design", John Wiley.
7. Lyla "Embedded Systems", Pearson, 2013.

[ECS19011] Embedded System Lab II

Teaching Scheme:
Lectures: 4 Hrs/week

Examination Scheme:
Continuous Assessment- 50 Marks
Final Practical/Oral Exam – 50 Marks

Course Outcomes:

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

1. Demonstrate use of instructions and Interrupt Processing in embedded processor
2. Write, Test and Debug programs in embedded board.

Syllabus contents:

After understanding of MSP 430 architecture inclusive of Memory, I/O, Pipeline, Lab assignments will be based on use of instruction set, ISS, Communication/Display/User Interface Peripherals/Serial/PWM to solve specific embedded problems, power, Foot Print, Interrupt Latency, Real Time Response, introduction to Real Time Operating System Concepts.

References:

1. Atmega 32 datasheet
2. MSP 430 datasheet
3. MSP 430 Technical Reference Manual
4. AVR Microcontroller and Embedded Systems by Muhammad Ali Mazidi, Pearson Publication.

[ECS19012] HIL LAB

Teaching Scheme:
LAB: 2 hrs/week,

Examination Scheme:
Continuous Evaluation : 50 Marks
End-Sem Exam: 50 Marks

Course Outcomes:

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

1. To mathematically formalize requirements based on design objectives.
2. The students will be able to trace the design project requirements through modeling, control design, and V&V.
3. The students will be able to perform analysis and design in the discrete domain using ADC and DAC.
4. The students will gain knowledge and hands on experience with sensor and actuator calibration, signal amplification, sampling, DAC and ADC, uncertainties and noise, continuous and discrete filters, safety measures for HIL implementations, *etc*.
5. The students will be able to independently setup HIL experiments using SIMULINK and dSpace virtual HIL software packages.
6. Through a project, students will learn to develop and implement a Design of Experiments (DOE) for requirements validation using HIL simulations.

Syllabus contents:

Two lab sessions to work with MATLAB/SIMULINK. The goal being to develop the model and controller, and validate and verify their SIMULINK files according to the predefined requirements. The learning objectives of the first two lab sessions were— 1) Develop and debug the model/controller in MATLAB/SIMULINK, 2) Design MIL tests in order verify and validate the model/controller according to predefined requirements, 3) Generate and debug production code, and performing SIL tests, 4) get hands on experience of V&V tools in MATLAB/SIMULINK

dSPACE software package and verifying/validating their developed code with VHIL. The learning objectives of these three lab sessions were — 1) Independently setting up VHIL, and recording data using data acquisition tools in dSPACE, 2) Learning to work with dSPACE software packages, 3) Designing and implementing DOE tests on the VHIL platform.

References:

Manuals of respective devices and software.

Departmental Elective I

[ECS(DE)-19003] Industrial Automation and Control

Teaching Scheme: | **Examination Scheme:**

Lectures: 3 hrs/week,

T1 and T2: 20 Marks each

End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Select suitable component for given applications, built suitable control strategy for application.
2. Learn the elements of building automation and application in Social, Environmental, and Industrial areas.
3. To use communication protocols of industrial systems

Syllabus contents:

Introduction to Industrial Automation and Control, Architecture of Industrial Automation Systems. Introduction to sensors and measurement systems, Temperature measurement, Pressure and Force measurements Displacement and speed measurement Flow measurement techniques, Measurement of level, humidity, pH etc. Signal Conditioning and Processing Estimation of errors and Calibration

Introduction to Process Control PID Control , Controller Tuning. Implementation of PID Controllers Special Control Structures: Feedforward and Ratio Control. Predictive Control, Control of Systems with Inverse Response, Cascade Control, Overriding Control, Selective Control, Split Range Control Introduction to Sequence Control, PLCs and Relay Ladder Logic, Sequence Control : Scan Cycle, RLL Syntax

Sequence Control : Structured Design Approach, Sequence Control : Advanced RLL Programming Sequence Control : The Hardware environment, Control of Machine tools : Introduction to CNC Machines

Control of Machine tools : Analysis of a control loop

Introduction to Actuators: Flow Control Valves, Hydraulic Actuator Systems : Principles, Components and Symbols.

Hydraulic Actuator Systems : Pumps and Motors, Proportional and Servo Valves, Pneumatic Control

Pneumatic Control Systems : Controllers and Integrated Control Systems

Electric Drives : Introduction, Energy Saving with Adjustable Speed Drives, DC--DC Converters, Adjustable Speed Drives, Induction Motor Drives: Introduction, Characteristics, Adjustable Speed Drives Synchronous Motor Drives : Motor Principles, Adjustable Speed and Servo Drives Networking of Sensors, Actuators and Controllers : The Fieldbus , The Fieldbus Communication Protocol. Introduction to Production Control Systems.

References:

1. Frank Lamb, “ Industrial Automation: Hands On”

2. Jon Stenerson, “ Industrial Automation and Process Control”
3. Kevin Collins, “ PLC Programming for Industrial Automation”
4. A.K. Gupta, S.K. Arora, Jean Riescher Westcott, “ Industrial Automation and Robotics: An Introduction”

[ECS(DE)-19001] Probability and Statistics

Teaching Scheme:
Lectures: 3 hrs/week,

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Appreciate the importance of probability and statistics in computing and research
2. Develop skills in presenting quantitative data using appropriate diagrams, tabulations and summaries Use appropriate statistical methods in the analysis of simple datasets
3. Interpret and clearly present output from statistical analyses in a clear concise and understandable manner.

Syllabus contents:
Sets and classes, limit of a sequence of sets, rings, sigma-rings, fields, sigma-fields, monotone classes. Classical, relative frequency and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' Theorem and independence, problems.
Discrete, continuous and mixed random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, moments, probability and moment generating function, median and quantiles, Markov inequality, Chebyshev's inequality, problems. Discrete uniform, binomial, geometric, negative binomial, hyper geometric, Poisson, continuous uniform, exponential, gamma, Weibull, Pareto, beta, normal, lognormal, inverse Gaussian, Cauchy, double exponential distributions, reliability and hazard rate, reliability of series and parallel systems, problems. Function of a random variable, problems.
Joint, marginal and conditional distributions, product moments, correlation and regression, independence of random variables, bivariate normal distribution, problems. functions of random vectors, distributions of order statistics, distributions of sums of random variables, problems. The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Chi-Square, t and F distributions, problems.
Graphical representation, measures of locations and variability.
Unbiasedness, consistency, the method of moments and the method of maximum likelihood estimation, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for proportions, problems.
Null and alternative hypotheses, the critical and acceptance regions, two types of error, power of the test, the most powerful test and Neyman-Pearson Fundamental Lemma, tests for one sample and two sample problems for normal populations, tests for proportions, Chi-square goodness of fit test and its applications, problems.

References:

1. V.K. Rohatgi & A.K. Md. E. Saleh, "An Introduction to Probability and Statistics"

2. J.S. Milton & J.C. Arnold , “Introduction to Probability and Statistics”
3. H.J. Larson, “ Introduction to Probability Theory and Statistical Inference”
4. S.M. Ross, “A First Course in Probability Introduction to Probability and Statistics for Engineers and Scientists”
5. W.W. Hines, D.C. Montgomery, D.M. Gpldsman & C.M. Borror, “Probability and Statistics in Engineering”
6. M. Kac, “Lectures in Probability” (for example on independent events)
7. C.K. Wong (1972), “A note on mutually independent events. Annals of Statistics, V. 26, 27.(for example on independent events)”
8. P. Halmos, “Measure Theory(for algebra of sets)”

[ECS(DE)-19002] System Identification

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs/week,	T1 and T2: 20 Marks each
	End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Estimate correlation analysis
2. Identify of linear nonparametric and parametric models.
3. Demonstrate concept of adaptive control, Gain scheduling Control, MRAC, Direct and Indirect Adaptive Control, Adaptive Pole Placement Control.

Syllabus contents:

Review of probability theory and random variables: transformation (function) of random variables, conditional expectation, development of first principle models and liberalization, state estimation for linear perturbation models (Durenberger observer), Development of grey box models, discrete time series models: FIR and ARX models, development of ARX models by least square estimation, unmeasured disturbance modeling: ARMAX, OE, Box-Jenkins's models, Parameter estimation using prediction error method and instrumental variable method, maximum likelihood estimation, distribution of bias and variance errors, input signals, recursive approaches to identification, controller design. Introduction to adaptive control.

References:

1. Papoulis, "Probability, Random Variables and stochastic processes", 2nd Ed., McGraw-Hill, 1983.
2. George E.P.Box, Gwilym M.Jenkin, George C. Reinsel, "Time series analysis, for casting and Control".
3. L. Ljung, "System Identification Theory for the user", Prentice-Hall, 1999.
4. Rik Pintelon, John Schouleens, "System Identification", IEEE Press.
5. Young, Peter, "Recursive Estimation and Time Series Analysis", Springer Verlag Berlin, 1984.
6. Soderstrom and Stoica, "System Identification", Prentice Hall, 1989.
7. Karl J. Astrom, Bjorn Wittenmark, "Adaptive Control" second edition

[ECS(DE)-19004] Machine Learning (MOOC)

Teaching Scheme:
Lectures: 3 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Outline basic concepts of machine learning.
2. Identify the fundamental issues and challenges of machine learning algorithms.
3. Build a wide variety of learning algorithms.
4. Designing and Applying the machine learning algorithms to real world problems

Syllabus Contents:

Introduction to Machine Learning: Basic definitions, types of learning, designing a learning system, perspectives and issues, hypothesis space and inductive bias, evaluation, cross- validation. Linear regression, Decision trees, Splitting Criteria, Issues in decision tree learning, over-fitting and evaluation, nearest neighbor methods. Neural network: Perceptron, multilayer network, back propagation, introduction to deep neural network. Dimensionality Reduction: Feature reduction, Principal Component Analysis, Fischer's Discriminant Analysis. Probability and Bayes learning, Naive Bayes Model, Logistic Regression, Reinforcement learning. Support Vector Machine, Kernel function and Kernel SVM, Clustering: partitioning, k-means clustering, hierarchical clustering, and Case studies

References:

1. Ethem Alpaydin, “Introduction to Machine Learning”, Second Edition, The MIT Press, 2010.
2. Tom Mitchell, “Machine Learning”, McGraw-Hill, 1997.
3. Stephen Marsland, “Machine Learning: An Algorithmic Perspective”, CRC Press, 2009.
4. Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.

[ECS(DE)19013] Automotive Embedded Product Development
HELLA –COEP Automotive Electronics Program (Elective-1)

Teaching Scheme:
Lectures: 3 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Complimentary lab sessions will be organized to ensure hands-on learning

Course Outcomes:

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

1. Acquire automotive product development understanding
2. Learn Project Management concept
3. Apply processes, methods and tools to demonstrate learning

Syllabus Contents:

- **Automotive system overview & product development:** Major Automotive trends (e-mobility, Autonomous Driving, Comfort & Connected Cars), Vehicle EE architecture, product. Integration of Mechanical, Software, Hardware domains and their interdependences, Design for x Abilities (manufacturability, testability, serviceability, maintainability, Overview of Design guidelines.
- **Process, methods & tools:** Requirement Engineering and version control tools: DOORs, PTC, V model, Product Engineering Process, Automotive spice, TS 16949, Key Performance Indicators for development.
- **Product reliability, safety & quality:** DFMEA, PFMEA, Warranty, Design Validations, Process Validations, Customer Line Return, Non Quality Expenses, First Pass Yield, Statistical tools, ASIL levels, Safety Goals, Safety Measures, HARA, FMEDA,ISO 26262.
- **Project Management & Organization:** Matrix Organization, Line responsibilities, Functional responsibility, Team work, Leadership, Scope management, Scheduling, Cost, Monitoring & Tracking, Engineering Change Management, Milestones.

Departmental Elective II

[ECS(DE)-19005] Intelligent Control

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. To justify the use of intelligent control systems.
2. Design Fuzzy Logic Control System for any Engineering Application.
3. Design Neural Network based Control System for any Engineering Application.
4. Apply Genetic Algorithms to Parametric Optimization.

Syllabus contents:

Artificial Neural Networks, Learning Methods, Supervised and Unsupervised learning, Recurrent Neural Networks. Fuzzy logic, Fuzzy Arithmetic, Relations, Reasoning, Mamdani and Takagi-Sugeno knowledge representation and inference mechanism, genetic algorithm, Fuzzy Neural networks.
System Identification using Neural and Fuzzy Neural Networks, Stability analysis. Adaptive control using Neural and fuzzy Neural networks, Direct and Indirect adaptive control, and Self-tuning PID Controllers. Introduction to Genetic Algorithm and use of GA for Parametric Optimization. Intelligent control applications such as robot manipulator dynamic control, inverted pendulum.

References:

1. K. Passino, "Biomimicry for Optimization, Control and Automation", springer verlag,2005.
2. Kevin M. Passino and Stephen Yurkovich, "Fuzzy Control", Addison Wesley Longman, Menlo park, CA 1998.
3. Antsaklis P.J., PassinoK. M., "An Introduction to and Autonomous Control", Kluwer Publishers' Norwell MA 1993.
4. Timothi J. Ross, "Fuzzy logic with engineering applications", Wiley, 1995.
5. Rossiter, J.A., "Predictive Control: a practical approach "
6. Stanislaw H. Zak , "Systems & Control"

[ECS(DE)-19006] Adaptive Control

Teaching Scheme:
Lectures: 3 hrs/week,

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Analyze the stability of an adaptive linear system
2. Design a MRAC or L1 adaptive controller
3. Design and simulate indirect/direct adaptive controllers
4. Design adaptive parameter identifiers

Syllabus contents:

Introductory Concepts: Representative process control problems -Liquid Surge Tank, Blending Process. Incentives for Chemical Process Control. Classification of variables and design elements of a control system.

Modeling Considerations: Rationale for process modeling. General modeling principles; balance equations - mass, energy, momentum; Thermodynamics and reaction kinetics; degrees of freedom analysis. State variables, State equations; input-output models. Lumped and distributed parameter systems. Steady state and dynamic behavior. Examples – liquid serge tank, isothermal chemical reactor.

Dynamic behavior of Chemical Processes: Solving algebraic equations and integration of ODEs. Concept of nonlinearity; linearization of nonlinear processes; deviation variables. Concept of Laplace Transform (LT); the LT of basic functions - step, impulse, pulse, ramp, exponential, integral, derivative, time delay; initial and final value theorems. Solution of differential equation using LT techniques - Partial fraction expansion, direct division. Transfer function of Single Input Single Output (SISO) process; Transfer function matrix of Multi Input Multi Output (MIMO) process. Properties of transfer function; Poles and Zeros of a transfer function; stability issues, unstable and non-minimum phase behavior. Dynamic response of a first order process, first order plus dead time process, second order process, pure capacitive process, pure dead time, higher order process; inverse response; Padé approximation. Interacting and non-interacting processes. Development of Empirical model - Model development using linear and nonlinear regression, fitting first and second order models using step test results. Frequency response analysis - Bode and Nyquist plot.

Feedback controller: Introduction to feedback control. Elements of Control loop - controller, measuring device, final control element, transmission lines, transducers, transmitters, block diagram. Concept of servo and regulatory problems. Selection of measured, manipulated and controlled variables. Types of controller - P, PI, PID, on-off. Effects of proportional, integral and derivative actions. Notion of stability - characteristic equation, Routh-Hurwitz criteria, root-locus analysis. Design of feedback controller - performance criteria, controller tuning methods, Cohen-Coon method, 1/4th 12 decay ratio method, direct synthesis methods, gain and phase margins, Ziegler-Nichols method, Bode & Nyquist stability criteria, robustness analysis. Compensation for large dead time and inverse response, Smith Predictor.

Other control strategies: Feed forward controller - design with steady state model, design with dynamic model, combination of feed forward-feedback structure. Cascade control structure - analysis and design. Ratio control, split range control, selective control, overrides control, auctioneering control. Concepts of adaptive and inferential control.

Multi loop multivariable control: Process and control loop interaction. Singular Value Decomposition (SVD), Relative Gain Array (RGA), I/O pairing. Sensitivity to model uncertainty; failure sensitivity. Decoupling and design of non-interacting control loops. Example - Design of controller and control structure for a 4 input x 4 output Distillation Column.

Instrumentation: Final Control Elements - Valve characteristics, thyristors. Measuring Devices for flow, temperature, pressure and level. Instrumentation symbols. Introduction to Process Flow Diagram (PFD) and Piping & Instrumentation Diagram (P&ID).

References:

1. Stephanopoulos, G., " Chemical Process Control: An Introduction to Theory and Practice ", Prentice-Hall, New Jersey, 1984.
2. Coughanowr, D. R. and L. B. Koppel, "Process systems Analysis and Control ", Mc-Graw-Hill, 2nd. Ed., 1991.
3. Luyben, W. L.," Process Modelling Simulation and Control for Chemical Engineers ", McGraw Hill, 1990.

[ECS(DE)-19007] Sliding Mode Control

Teaching Scheme: Lectures: 3 hrs/week,

Examination Scheme: T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Design and analyze sliding mode controller for uncertain systems
2. Design estimators for state and uncertainty estimations.
3. Design and analyze discrete sliding mode controller.

Syllabus Contents:

Notion of variable structure systems and sliding mode control, Design continuous sliding mode control, chattering issue, Alleviation of chattering. Integral Sliding Mode Control. Sliding Mode Observer for state estimation. Discrete sliding mode control analysis and design. Discrete disturbance estimator. Discrete output feedback SMC using multi rate sampling. Introduction to higher order sliding mode control, twisting and super twisting algorithms

References:

1. Spurgeaon and Edwards, "Sliding Mode Control Theory and Applications".
2. B. Bandyopadhyay and S. Janardhanan , "Discrete-time Sliding Mode Control : A Multirate-Output Feedback Approach", Ser. Lecture Notes in Control and Information Sciences, Vol. 323, Springer-Verlag, Oct. 2005.
3. Yuri Shtessel , Christopher Edwards, Leonid Fridman ,Arie Levant "Sliding Mode Control and Observation" Birkhauser
4. S. Kurode, B. Bandyopadhyay and P.S. Gandhi, "Output feedback Control for Slosh free Motion using Sliding modes", Lambert Publications 2012.

[ECS(DE)-19008] Automotive Electronics: Hardware Development
HELLA –COEP Automotive Electronics Program (Elective:2)

Teaching Scheme:
Lectures: 3 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Complimentary lab sessions will be organized to ensure hands-on learning

Course Outcomes:

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

1. Acquire automotive specific hardware design skills.
2. Apply concept such as DFM, DFT, EMC, DFMEA.
3. Apply processes, methods and tools to demonstrate learning

Syllabus Contents:

- **Low Power Domain:** 16/32 bit controllers, Hardware-Software Interfaces, communication interfaces-CAN, LIN, SPI, wireless interfaces- Bluetooth ,ISM band applications, I/O interfaces – digital, analog signal conditioning, switches, relays, high side, low side drivers, Introduction to design tools (Microcap, Cadence Concept HDL and Allegro).
- **High Power Domain**: Selection of power switching devices- MOSFETs/IGBTs/SiC/ GaNFETs, Gate driver design, power loss calculations, thermal management, Design consideration For High Voltage applications.
- **Electromagnetic Compatibility**: Introduction to various regulatory requirements and International electrical and EMC standards, Understanding origin of pulses, disturbances, circuit and PCB layout design techniques to meet EMC.
- **Design for Manufacturability and Testability:** PCB layout consideration, manufacturing interfaces and process flow, ICT, AOI and EOL testing.

Department Elective -III
[ECS(DE)-19009] Control Related Estimations

Teaching Scheme:
Lectures: 3 hrs/week,

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Build Kalman filters for state estimation
2. Design the model based estimator
3. Predict the diagnosis using estimation

Syllabus contents:

Introduction to random variables mean variance, normal distribution, stochastic estimation, Introduction to Kalman Filter, Kalman filter elementary approach, linearized and extended Kalman filter. Unscented kalman filter, particle filter, Model based estimation of states and disturbance. Robust estimation. Use of estimation approach for detection and diagnosis.

References:

1. Charles K. Chui, Guanrong Chen," Kalman Filtering: With Real-Time Applications", Springer Notes
2. Harold Wayne Sorenson," Kalman Filtering: Theory and Application", IEEE Press, 1960.

[ECS(DE)-19010] Fractional Order Modeling & Control

Teaching Scheme:
Lectures: 3 hrs/Week,

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Illustrate concept of fractional calculus
2. Develop fractional order models.
3. Design and analyze fractional control
4. Analyze fractional systems

Syllabus contents:

Review of basic definitions of integer-order (IO) derivatives and integrals and their geometric and physical interpretations, Computation of these FDs for some basic functions. Laplace and Fourier transforms of FDs. Study of basic functions like Gamma function, Mittag-Leffler function, Dawson's function, Hyper geometric function Analysis of linear fractional-order differential equations (FDEs): formulation, Solution with different FDs, Initial conditions, Problem of initialization and the remedies. Analysis of fractional-order (FO) modeling, Models of basic circuits and mechanical systems using FO elements, Concept of anomalous diffusion, non-Gaussian probability density function and the development of corresponding FO model, FO models of heat transfer, A brief overview of FO models of biological systems. Fractional-order transfer function (FOTF) representation, stability, impulse, step and ramp response, Frequency response, non-minimum phase systems, Root locus, FO pseudo state-space (PSS) representation and the associated concepts like solution of PSS model, controllability, observability, FO lead/lag compensators, FO PID control, design of FO state-feedback, Realization and implementation issues for FO controllers Analysis of system of non-linear FDEs.

References:

1. K. B. Oldham and J. Spanier, The Fractional Calculus. Dover Publications, USA, 2006.
2. Kilbas, H. M. Srivastava, and J. J. Trujillo. Theory and Applications of Fractional Differential Equations. Elsevier, Netherlands, 2006.
3. Podlubny Fractional Differential Equations. Academic Press, USA, 1999.
4. A. Monje, Y. Q. Chen, B. M. Vinagre, D. Xue, and V. Feliu. Fractional-order Systems and Control: Fundamentals and Applications. Springer-Verlag London Limited, UK, 2010.
5. R. L. Magin. Fractional Calculus in Bioengineering. Begell House Publishers, USA, 2006.
6. R. Caponetto, G. Dongola, L. Fortuna, and I. Petras. Fractional Order Systems: Modeling and Control Applications. World Scientific, Singapore, 2010.

7. K. S. Miller and B. Ross. An Introduction to the Fractional Calculus and Fractional Differential Equations. John Wiley & Sons, USA, 1993.
8. S. Das,"Functional Fractional Calculus for System Identification and Controls". Springer, Germany, 2011
9. Ortigueira, " Fractional Calculus for Scientists and Engineers". Springer, Germany, 2011.
10. Petras. "Fractional-Order Nonlinear Systems: Modeling, Analysis and Simulation. Springer", USA, 2011.
11. W. R. LePage. "Complex Variables and the Laplace Transform for Engineers. Dover Publications", USA, 2010.
12. H. Ruskeepaa. "Mathematic Navigator: Mathematics, Statistics and Graphics". Academic Press, USA, 2009.

[ECS(DE)-19011] Modeling & Control of Power Electronics Converters

Teaching Scheme:
Lectures: 3 hrs/Week,

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Analyze and model the behavior of converters.
2. Design and control for the desired performance.
3. Explore the stability of the controller

Syllabus contents:

Switched and averaged models; small/large signal models; time/frequency models. Analysis of models. Linear control approaches normally associated with power converters; resonant controllers Nonlinear control methods including feedback linearization, stabilizing, passivity-based, and variable-structure control.

References:

1. Seddik Bacha, Iulian Munteanu, Antoneta Iuliana Bratcu "Power Electronics Converters Modeling & Control" Springer.
2. Keng C. Wu, "Switched Mode Power Converters: design and analysis", Elseware academic press
4. K. Kit Sum, "Switch Mode Power Conversion: Basic Theory and Design",

[ECS (DE) 19012] Automotive Electronics: Software Development

Teaching Scheme:
Lectures: 3 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Acquire automotive specific software design skills.
2. Apply concepts such as AUTOSAR, MATLAB, and Communication Protocol.
3. Apply processes, methods and tools to demonstrate design skills

Syllabus Contents:

Software Architecture: Classical architecture, Layered Architecture (AUTOSAR), All layer information (e.g. RTE, BSW, Application) Tool: Davinci developer, configurator, Raphsody.
Communication Protocols: Communication Protocol, CAN, LIN, Automotive Ethernet, RF, Bluetooth, Wi-Fi, Diagnostic Protocol: UDS, Tools: CANoe, Vehicle spy, CAPEL ,TAE scripting.
Model Based Development: Model Based Development: Algorithm/application development using Simulink, stateflow, code generator.
Embedded C: Concepts of C (structure, union, pointer, bitwise operator), Logic building according to requirement, MISRA C guidelines.
Software Testing: Unit testing, Model in loop(MIL) testing, module testing, integration testing, software in loop(SIL) testing, Hardware in Loop (HIL) testing,. Tools: Tessy, PolySpace, TPT, Winidea, QAC, HIL Test Setup.

SEMESTER – III

[20001] Dissertation Phase – I

Course Outcomes:

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

1. Identify key research and development topics in the field of chosen dissertation area (Power Systems, Power electronics, Electrical machines, Energy systems and any interdisciplinary area).
2. Identify, summarize and critically evaluate relevant literature and write a literature review on the relevant topic.
3. Manage time effectively whilst working on independent research and prepare action plan.
4. Show evidence of clarity of argument, understanding of the chosen topic area, and presentation of technical information.
5. Use and develop written and oral presentation skills.

Syllabus Contents:

The M. Tech. project is aimed at training the students to analyze independently any problem in the field of Electrical Engineering or interdisciplinary. The project may be analytical, computational, experimental or a combination of three. The project report is expected to show clarity of thoughts and expression, critical appreciation of the existing literature and analytical, experimental, computational aptitude.
The student progress of the dissertation work will be evaluated in stage I by the departmental evaluation committee

References:

1. Various books, research papers, patents and IPRs on the topic selected for the dissertation.

[20002] Project and Finance Management

Teaching Scheme:
Lectures: 3 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Demonstrate project management skills.
2. Analyze risk and manage it.
3. Illustrate project financial evaluation
4. Utilize specialized economic evaluation techniques to determine and evaluate project feasibility.

Syllabus Contents:

Project organization and contracts, Construction finance, Public-private partnerships in financing of infrastructure, Private finance initiative, Project finance, How to get involved in private finance, Risk analysis, Risk management, Project financial evaluation, Capital program management, Project control, Project management engineering, procurement and construction, Identifying and covering risks—current trends, Project uncertainty management. Term project presentation

References:

1. Online MOOC course material available in the selected area
2. Shtub, Bard and Globerson, “Project Management: Engineering, Technology, and Implementation”, PH Inc.
3. Khan, M.Y & Jain, P.K.: Financial Management; Tata McGraw Hill, New Delhi, 2008
4. Keown, Martin, Petty and Scott (Jr): Financial Management; Principles and Applications; Prentice Hall of India, New Delhi, 2002.

SEMESTER - IV

[20003] Dissertation Phase – II

Course Outcomes:

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

1. Manage time and other resources effectively whilst working on independent research.
2. Identify, analyse and interpret suitable data to enable the research question to be answered.
3. Model, Simulate/ develop innovative hardware/ develop new algorithms/ emulate/ HIL/ develop prototype for the selected topic.
4. Describe the process of carrying out independent research in written format and report your results and conclusions with reference to existing literature and Analyze and synthesize research findings.
5. Use and develop written and oral presentation skills and Prepare good technical project reports for publication in journals and conferences.
6. Take up challenging issues in industry and provide solutions.

Work Contents:

The M. Tech. project is aimed at training the students to analyze independently any problem in the field of Electrical Engineering or interdisciplinary. The project may be analytical, computational, experimental or a combination of three. The project report is expected to show clarity of thoughts and expression, critical appreciation of the existing literature and analytical, experimental, computational aptitude.
The student progress of the dissertation work will be evaluated in stage II by the departmental evaluation committee and final viva voce will be conducted by the external examiner.

References:

1. Various books, research papers, patents and IPRs on the topic selected for the dissertation.

[20004] Design of Internet of Things

Teaching Scheme:
Lectures: 3 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Illustrate the application areas of IOT ·
2. Realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks ·
3. Demonstrate building blocks of Internet of Things and characteristics.

Syllabus Contents:

Introduction to IoT, Sensing, Actuation, Basics of Networking, Basics of Networking, Communication Protocols, Communication Protocols, Sensor Networks, Sensor Networks, Machine-to-Machine Communications, Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino, Introduction to Python programming, Introduction to Raspberry, Implementation of IoT with Raspberry Pi, Introduction to SDN, SDN for IoT, Data Handling and Analytics, Cloud Computing, Cloud Computing, Sensor-Cloud, Fog Computing, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT, Industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring.

References:

1. Adrian McEwen Hakim Cassimally, “Designing the Internet of Things”, Publisher: JOHN WILEY & SONS INC
2. NPTEL Course on “Design of Internet OF Things” by Prof. T V Prabhakar from IISC Bangalore.