M. Tech. (Electrical)
Specialization: Embedded Control Systems

Program Education Objectives (PEOs)

The Postgraduate students will demonstrate..

I. Employability in the diversified sectors such as public or private organization and institute or pursue higher studies.

II. Measurable progress in the chosen field.

III. Attitude of lifelong learning and skills of effective inter-person communication.

Program Outcomes (POs)

Students will be able to..

1. Acquire and apply the knowledge of domain engineering for system modelling, analysis and problem solving.
2. Design control for various systems.
3. Use simulation software and embedded tools for analysis and implementing controller.
4. Solve the problems which need critical and independent thinking leading to reflective Learning
5. Communicate at different levels effectively
6. Explore ideas for inculcating research skills.
7. Sense and demonstrate the professional ethics and social responsibility.
8. Function as a member of a multidisciplinary team.
9. Acquire attitude of lifelong learning.
10. Execute project and finance management.

M. Tech. (Electrical)
Specialization: Embedded Control Systems

Correlation between the PEOs and the POs

PO→ PEO↓	1	2	3	4	5	6	7	8	9	10
I	✓	✓	✓	✓	✓	✓	✓	✓	✓	
II			✓	✓	✓	✓	✓	✓	✓	✓
III						✓	✓	✓	✓	✓

Note: The cells filed in with ✓ indicate the fulfilment/correlation of the concerned PEO with the PO.

M. Tech. (Electrical)
Specialization: Embedded Control Systems

Correlation between the POs and the COs

Semester - I

Sr. No.	Course Code	Course Name	COs	POs									
				1	2	3	4	5	6	7	8	9	10
1.	OEC	Engineering OPtimization	A. Explain and use the basic theoretical principles of optimization and various optimization techniques.	✓					✓		✓		
			B. Develop and select appropriate models corresponding to problem descriptions in engineering and solve them correctly.	✓					✓		✓		
			C. Apply appropriate optimization techniques to solve engineering problems	✓			✓		✓		✓		
			D. Implement various optimization software tools to solve electrical problems.	✓					✓		✓		
2.	PSMC	Mathematical Modeling and Analysis of Dynamic Systems	A. Develop mathematical models of various engineering and physical systems using classical and energy approach	✓			✓						
			B. Linearize the nonlinear system using different techniques	✓			✓						
			C. Analyze the model from control perspective and use software tool to demonstrate analysis.	✓		✓	✓						
3.	PCC	Digital Control Systems	A. Obtain discrete representation of LTI systems.	✓			✓						
			B. Analyze stability of open loop and closed loop discrete system	✓									

			C. Design and analyze Discrete Controller and estimator	✓	✓	✓	✓							
4.	PCC	Advanced Linear Control Systems	A. Analyze Linear control system using vector spaces	✓			✓							
			B. Design of linear control system using state space to achieve desired system performance	✓	✓		✓							
			C. Linear quadratic regulator design to achieve desired system performance	✓	✓		✓							
5.	LC	Control System Simulation Lab	A. Use advanced software tools like Matlab , PSIM for analyzing the system performance.	✓		✓								
			B. Simulate the dynamic system and its control	✓		✓								
			C. Analyze and interpret the results	✓		✓								
6.	LC	Embedded Control Lab I	A. Demonstrate use of instructions and Interrupt Processing in embedded processor	✓		✓								
			B. Write, Test and Debug programs in embedded board	✓		✓								
7.	MLC	Research Methodology	A. Understand research problem formulation.	✓										
			B. Analyze research related information.	✓										
			C. Follow research ethics.							✓				
8.	MLC	Humanities	A. Describe development of Civilization, Culture and Social Order over the Centuries							✓				
			B. Sense the development of Technology and its impact on the Society's Culture and vice-versa, as well as the concept of Globalization and its effects.							✓				

			C. Realize the process of Industrialization and Urbanization, their positive and negative effects, like social problems, etc.							✓			

M. Tech. (Electrical)
Specialization: Embedded Control Systems

Correlation between the POs and the Cos

Semester - II

Sr. No.	Course Code	Course Name	COs	POs									
				1	2	3	4	5	6	7	8	9	10
1.	PCC	Sliding Mode Control	A. Design and analyze sliding mode controller for uncertain systems	✓	✓	✓	✓						
			B. Demonstrate capability to design estimators for state and uncertainty estimations	✓	✓	✓	✓						
			C. Design and analyze discrete sliding mode controller.	✓	✓	✓	✓						
2.	PCC	Nonlinear Dynamical Systems	A. Explore tools for stability analysis and response evaluation of control problems with significant nonlinearities	✓		✓							
			B. Identify the design problem and distinguish between the controls strategies	✓	✓		✓						
			C. Correlate between design parameters and the system performance.	✓									
3.	PCC	Embedded System Design	A. Deploy low end applications using low and high level languages on microcontroller platform.	✓			✓						
			B. Test and debug peripherals in embedded system	✓	✓		✓						
			C. Identify, design and implement applications on embedded platform	✓	✓		✓						
4.	DEC	a. Intelligent Control Systems	**Elective I**										
			A. Understand the characteristics, uses and limitations of classical and	✓									

			modern intelligent control.											
			B. Gain an understanding of the functional operation of a variety of intelligent controls, their bio-foundations and modern heuristic optimization techniques.	✓										
			C. Design and apply simple soft computing and intelligent control methods using MATLAB-SIMULINK and toolboxes.		✓	✓	✓							
		b. System Identification	A. Understand correlation analysis.	✓										
			B. Identify of linear nonparametric and parametric models.	✓	✓	✓	✓							
			C. Demonstrate concept of adaptive control, Gain scheduling Control, MRAC	✓	✓									
		c. Modeling & Control of Power electronics converters	A. Develop the mathematical models of converters	✓										
			B. Analyze the behaviour of conerters	✓										
			C. Design the control for the desired performance		✓	✓	✓							
		d. Any other course approved by DPPC												
5.	DEC	**Elective – II**												
		a. Control Related Estimations	A. Analysis of random variable	✓										
			B. Design Kalman Filters for state estimation	✓	✓		✓							
			C. Observer Design for state and disturbance estimation .	✓	✓	✓	✓							
		b. Fractional	A. Use fractional Calculus for developing Fractional order	✓										

		Order Modeling & Control	model of systems.										
			B. Analyze fractional systems.	✓									
			C. Design and Analyze fractional order control	✓	✓		✓						
		c. Energy Storage Systems	A. Understand the emerging needs of Electrical Energy Storage Systems.	✓									
			B. Analyze the performance of various Electrical Energy Storage Systems	✓									
			C. Assess the markets for the Electrical Energy Storage Systems.	✓			✓						
		d. Any other course approved by DPPC											
6.	LC	Embedded System Lab 2	A. create/debug and develop applications in C for embedded environment	✓		✓							
			B. write low level device drivers/Chip Support Libraries for standard peripherals such as UART/PWM/Timers	✓	✓	✓	✓						
			C. Develop a embedded controller for some application	✓	✓	✓	✓						
7.	MLC	Intellectual Property Rights	A. Understand that today's world is controlled by Computer, Information Technology, but tomorrow's world will be ruled by ideas, concept, and creativity.							✓	✓		
			B. Understand that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among							✓	✓		

			students in general & engineering in particular.											
			C. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits	✓						✓	✓		
8.	LLC	Liberal Learning Course	A. Learn new topics from various disciplines without any structured teaching or tutoring								✓		
			B. Understand qualitative attributes of a good learner								✓		
			C. Understand quantitative measurements of learning approaches and learning styles								✓		
			D. Understand various sources and avenues to harvest/gather information	✓							✓		
			E. Assess yourself at various stages of learning								✓		

M. Tech. (Electrical)
Specialization: Embedded Control Systems

Correlation between the POs and the Cos

Semester - III

Sr. No.	Course Code	Course Name	COs	POs									
				1	2	3	4	5	6	7	8	9	10
1.	SLC	Project & Finance Management	A. demonstrate project management skills										✓
			B. Analyze risk and manage it.										✓
			C. Illustrate project financial evaluation										✓
2.	Dissertation	Dissertation Stage I	A. Conceive a problem statement either from rigorous literature survey or from the requirements raised by external entity.	✓		✓	✓		✓	✓	✓		
			B. Analyze the problem critically	✓		✓	✓		✓	✓	✓	✓	✓
			C. Write document report .	✓		✓	✓			✓			
			D. Present the work done					✓		✓			

M. Tech. (Electrical)
Specialization: Embedded Control Systems

Correlation between the POs and the Cos

Semester - IV

Sr. No.	Course Code	Course Name	COs	POs									
				1	2	3	4	5	6	7	8	9	10
2.	Dissertation	Dissertation Stage II	A. Design, implement and test the prototype/algorithm in order to solve the conceived problem	✓	✓	✓	✓		✓		✓		✓
			B. Interpret and analyze the findings.	✓		✓	✓						
			C. Write the report	✓		✓				✓			
			D. Present the work done					✓		✓			
			E. Publish the research work in journals/conferences of repute contributing to growth of technology in the domain	✓		✓	✓	✓	✓	✓		✓	

M. Tech. (Electrical)
Specialization: Embedded Control Systems

Curriculum
(w. e. f. 2015-16)

List of Abbreviations

OEC- Institute level Open Elective Course
PSMC – Program Specific Mathematics Course
PCC- Program Core Course
DEC- Department Elective Course
LLC- Liberal Learning (Self learning) Course
MLC- Mandatory Learning Course (Non-credit course)
LC- Laboratory Course
SLC-Special Learning Course

M. Tech. (Electrcal)
Specialization: Embedded Control Systems
Structure

Semester I

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	OEC		Industrial control Components and Automation	3	--	--	3
2.	PSMC		Mathematical Modeling and Analysis of Dynamis Systems	3	1	--	4
3.	PCC		Digital Control Systems	3	1	--	4
4.	PCC		Advanced Linear Control Systems	3	--	--	3
6.	LC		Control System Simulation Lab	--	--	6	3
7.	LC		Embedded Lab I	--	--	6	3
10.	MLC		Research Methodology	1	--	--	--
11.	MLC		Humanities	1	--	--	--
			Total Academic Engagement and Credits	**14**	**1**	**12**	**20**

Semester II

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	PCC		Sliding Mode Control	3	-	--	3
2.	PCC		Nonlinear Dynamical Systems	3	--	--	3
3.	PCC		Embedded System Design	3	--	--	3
4.	DEC		**Elective – I**	3	--	--	3
			a. Intelligent Control Systems				
			b. System Identification				
			c. Modeling and Control of Power Converters				
			d. Any Other Course approved by DPPC				
5.	DEC		**Elective – II**	3	--	--	3
			a. Control Related Estimations				
			b. Fractional Order Modeling and Control				
			c. Energy Storage Systems				
			d. Any Other Course approved by DPPC				
6.	LC		Embedded Lab 2	--	--	6	3
9.	MLC		Intellectual Property Rights	1	--	--	--
10.	LLC		Liberal Learning Course	1	--	--	1
			Total Academic Engagement and Credits	**17**	**1**	**6**	**19**

Semester-III

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	SLC		Project Management & Finance(Mooc)	-	-	-	03
2.	Dissertation		Dissertation Phase – I	--	--	--	12
			Total Credits	**--**	**--**	**--**	**15**

Semester-IV

Sr. No.	Course Code	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	Dissertation		Dissertation Phase – II	--	--	--	20
			Total Credits	**--**	**--**	**--**	**20**

Semester – Wise Academic Engagement and Credits

Semester	Academic Engagement (In Hours)	Credits
I	**27**	**20**
II	**24**	**19**
III	**--**	**15**
IV	**--**	**20**
	Total Credits	**74**

(OEC) Engineering Optimization

Teaching Scheme
Lectures: 3 hrs/week

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

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

A. Explain and use the basic theoretical principles of optimization and various optimization techniques.
B. Develop and select appropriate models corresponding to problem descriptions in engineering and solve them correctly.
C. Apply appropriate optimization techniques to solve engineering problems Apply appropriate optimization techniques to solve the problems of power system.
D. Implement various optimization software tools to solve electrical problems.

Syllabus Contents:

Introduction to optimization, classical optimization: single variable, multivariable optimization techniques, linear programming: simplex method, duality, transportation problems, non-linear programming: one dimensional minimization methods, unconstrained optimization, dynamic programming: development of dynamic programming, principle of optimality, practical aspects of optimization: reduced basic techniques, sensitivity of optimum solution to problem parameters, modern optimization techniques

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. Gillette, “Computer Oriented Operation Research”, Mc-Graw Hill Publications.
5. Bazaraa M. S., Sherali H.D. and Shetty C. “Nonlinear Programming Theory and Algorithms”, John Wiley and Sons, New York 1993

(PSMC) Mathematical Modeling and Analysis of Dynamical Systems

Teaching Scheme
Lectures: 3 hrs/week
Tutorials: 1 hr/week

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

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

A. Develop mathematical models of various engineering and physical systems using classical and energy approach
B. Linearize the nonlinear system using different techniques
C. Analyze the model from control perspective and use software tool to demonstrate analysis.

Syllabus Contents:

Modelling by first principle approach of simple mechanical, electrical, thermal, chemical systems. Modelling by energy approach using Lagrangian and Hamiltonian.

Model order reduction, balancing. Linearization of nonlinear models, state space approach for analyzing the dynamic models

Modelling 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”

(PCC) Digital Control Systems

Teaching Scheme
Lectures: 3 hrs/week
Tutorials: 1 hr/week

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

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

A. Obtain discrete representation of LTI systems.
B. Analyze stability of open loop and closed loop discrete system .
C. Design and analyze Discrete Controller and estimator.

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,

Controllability, Reachability, Observability, Detectability and Stability of discrete time systems, state space analysis, pole placement, and observer

References:

1. K. Ogata,"Discrete Time Control Systems", Prentice hall, 1995.
2. Kannan M. Moudgalya,"Digital Control", John Wiley and Sons, 2004.
3. Kuo, Benjamin C, "Digital Control Systems", New York : Holt, Rinehart and Winston, 1980.
4. M. Gopal, "Digital Control", MacGraw Hill.
5. G. F. Franklin, J. D. Powell, M.L. Workman, Digital Control of Dynamic Systems, Addison-Wesley, Reading, MA, 1998.

(PCC) Advanced Linear Control Systems

Teaching Scheme
Lectures: 3 hrs/week

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

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

A. Analyze linear control system using vector spaces.
B. Design of linear control system using state space to achieve desired system performance
C. Linear quadratic regulator design 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, diagonalisation.

Linear System analysis in state space:
Controllability, Observability and Stability, Luapunov stability analysis of SISO and MIMO linear systems. Minimal realizations and co-prime fractions,

Control Design:
Design of pole placement controller and estimators for linear systems
Formulation of optimal control design problem, linear quadratic regulator (LQR) and optimum gain matrix, 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.

(LC) Control Systems Simulation Lab

Teaching Scheme
Practical: 6 hrs/week

Examination Scheme
Marks- 100

Laboratory Outcomes:

At the end of the laboratory work, students will demonstrate the ability to:

A. Demonstrate use of software tools for problem analyzing the system performance.
B. Simulate the dynamic system and its control

Software Tools:

1. MatLab
2. PSIM
3. Ansys

List of Experiments:

1. Develop m code for getting response of dynamic system.
2. Editing the plots
3. Develop Simulink Model of Dynamic System
4. Design and implement PID Controller, State feedback Controller, Estimator for linear dynamic System for the desired performance.
5. Use PSIM/Ansys Simulation Software
6. Study Different tool boxes in Matlab

(LC) Embedded Control Lab I

Teaching Scheme
Practical: 6 hrs/week

Examination Scheme
Marks- 100

Laboratory Outcomes:

At the end of the course, students will demonstrate the ability to:

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

Lab assignment:

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

(PCC) Sliding Mode Control

Teaching Scheme
Lectures: 3 hrs/week

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

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

A. Design and analyze sliding mode controller for uncertain systems
B. Design estimators for state and uncertainty estimations.
C. 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..

(PCC) Nonlinear Dynamical Systems

Teaching Scheme
Lectures: 3 hrs/week

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

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

A. Explore tools for stability analysis and response evaluation of control problems with significant nonlinearities
B. Identify the design problem and distinguish between the controls strategies
C. Correlate between design parameters and the system performance.

Syllabus Contents:

Introduction to nonlinear systems, phase plane and describing function methods for analysis of nonlinear systems

Lyapunov stability: autonomous systems invariance principle, linear systems and linearization, non-autonomous systems. linear time varying systems

Linearization, nonlinear control systems design by feedback linearization, input output linearization.

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

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.

(PCC) Embedded System Design

Teaching Scheme
Lectures: 3 hrs/week

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

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

A. Deploy low end applications using low and high level languages on microcontroller platform.
B. Test and debug peripherals in embedded system
C. 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, their operation, critical specifications, how to smartly choose elements from wide choice available in market. Various elements include Op amps, comparators, Instrumentation op amps, ADCs, DACs, DC-DC converters, isolators, level shifters, ESD protection devices. use case analysis . Systems on chop, 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. Developing Embedded Systems, Building Dependable Embedded Systems.

References:

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

(LC) Embedded Control Lab II

Teaching Scheme
Practical: 6 hrs/week

Examination Scheme
Marks- 100

Laboratory Outcomes:

At the end of the course, students will demonstrate the ability to:

A. Create/debug and develop applications in C for embedded environment.
B. Write low level device drivers/Chip Support Libraries for standard peripherals such as UART/PWM/Timers
C. Develop a embedded controller for some application

Lab assignment:

Embed PID Controller in MPC 234/MS320C2x for a classical second order system. Justify selection of sampling time for sensors and actuators, Simulate the control design, Deciding loop time based on sampling time, Describing transfer function, Tuning the PID Controller, Justify stability of system by considering the feasible sampling time, Interface the embedded controller using MPC 234/MS320C2x

References:

1. TI User Manuals TMS320C2x, TMS 28335
2. Website www.ti.com and www.DSPguide.com
3. Marven, C. , Ewers, G. A simple approach to DSP Texas Instr. 1993

(DEC-I) (a) Intelligent Control Systems

Teaching Scheme
Lectures: 3 hrs/week

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

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

A. Understand the characteristics, uses and limitations of classical and modern Intelligent control.

B. Gain an understanding of the functional operation of a variety of Intelligent Controls, their bio-foundations and modern heuristic optimization techniques.

C. Design and apply simple soft computing and intelligent control methods using MATLAB-SIMULINK and toolboxes.

Syllabus Contents:

Intelligent systems, control and intelligent systems Fuzzy and expert control (standard, Takagi-Sugeno, mathematical chararacterizations, design example), planning systems (autonomous vehicle guidance for obstacle avoidance, model predictive control), attentional systems (attentional strategies for predators/prey),

Learning and function approximation (function approximation problem), adaptive control introduction, learning/adaptation (training neural networks and fuzzy systems with least squares and gradient methods), stable fuzzy/neural adaptive control.

Evolutionary methods (genetic algorithm, evolutionary design), foraging, bacteria and connections to optimization and control, foraging, bees and connections to optimization, swarm stability (cohesion, foraging) competitive foraging games, coordinated vehicular guidance applications

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., Passino K.M. ,”An Introduction to Intelligent and Autonomous Control”, Kluwer Piblishers Norwell MA 1993.
4. Timothi J. Ross, ”Fuzzy logic with engineering applications”, Wiley, 1995.
5. Rossiter, J.A.,”Predictive Control: a practical approach

(DEC-I) (b) System Identification

Teaching Scheme
Lectures: 3 hrs/week

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

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

A. Understand correlation analysis
B. Identify of linear nonparametric and parametric models.
C. Demonstrate concept of adaptive control, Gain scheduling Control, MRAC,

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.

Development of grey box models, discrete time series models: FIR and ARX models, development of ARX models by least square estimation, unmeasured disturbance modelling. 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, Introduction to adaptive control scheme.

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,forcasting 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

(DEC-I) (c) Modelling & Control of Power Converter

Teaching Scheme
Lectures: 3 hrs/week

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

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

A. Develop the mathematical models of converters
B. Analyze the behaviour of converters
C. Design the control for the desired performance

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
3. K. Kit Sum," Switch Mode Power Conversion: Basic Theory and Design",

(DEC-II) (a) Control Related Estimation

Teaching Scheme
Lectures: 3 hrs/week

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

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

A. Analysis of random variable
B. Analyze and Design Kalman Filters for state estimation
C. Observer Design for state and disturbance estimation

Syllabus Contents:

Introduction to random variables mean variance, normal distribution, stochastic estimation, Least square 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. Peter S. Maybeck, " Stochastic Models, Estimation and Control " Vol I & II
2. Mohinder S. Grewal & Angus P. Andrews, "Kalman Filtering theory and Practice using MatLab" John Willey
3. Charles K. Chui, Guanrong Chen," Kalman Filtering: With Real-Time Applications ", Springer Notes
4. Harold Wayne Sorenson," Kalman Filtering: Theory and Application", IEEE Press, 1960 –

(DEC-II) (b) Fractional Order Modeling & Control

Teaching Scheme
Lectures: 3 hrs/week

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

Course Outcomes:

A. Use fractional Calculus for developing Fractional order model of systems.
B. Analyze fractional systems.
C. Design and Analyze fractional order control

Syllabus Contents:

Notion of Fractional derivative and integration. Study of basic functions like Gamma function, Mittag-Leffler function, Dawson's function, Hypergeometric function

Analysis of linear fractional-order differential equations, Analysis of fractional-order (FO) modeling, Non-Gaussian probability density function and the development of corresponding FO model.

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, Controllability, Observability,

FO compensators, FO PID control, design of FO state-feedback.

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. Mathematica Navigator: Mathematics, Statistics and Graphics. Academic Press, USA, 2009.

(DEC-II) (c) Energy Storage Syustem

Teaching Scheme
Lectures: 3 hrs/week

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

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

A. Understand the emerging needs of Electrical Energy Storage Systems.
B. Analyze the performance of various Electrical Energy Storage Systems
C. Assess the markets for the Electrical Energy Storage Systems.

Syllabus Contents:

The Role of Electrical Energy Storage Technologies in Electricity use. Emerging needs of Electrical Energy Storage (EES), The roles of EES.

Types of Electrical Energy Storage Systems, Classification, Mechanical, Electrochemical, Chemical, Electrical, Thermal Energy Storage systems, Standards and Safety involved.

Areas of applications of EES, Markets and forecast for EES.

References:

1. IEC White paper on Electrical Energy Systems: *www.iec.ch/whitepaper/pdf/iecWP*
2. Energy Storage Systems, Volume I and II, EOLSS,
3. *www. eolssunesco@gmail.com*
4. Energy Storage for Power Systems, A.G.Ter-Gazarian, Institution of Engineering and Technology, 2011.

(MLC) Research Methodology

Teaching Scheme
Lectures: 1 hr/week

Examination Scheme
Marks: 100

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

A. Understand research problem formulation.
B. Analyze research related information.
C. Follow research ethics.

Syllabus Contents:

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

Effective literature studies approaches, analysis

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

References:

1. Stuart Melville and Wayne Goddard, "Research methodology: An Introduction for Science and Engineering Students", Juta and Company Ltd.
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction", Juta and Company Ltd, 2004
3. Ranjit Kumar, "Research Methodology: A Step by Step Guide for Beginners", SAGE Publications, 2nd edition, 2005

(MLC) Humanities

Teaching Scheme
Lectures: 1 hr/week

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

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

A. Describe development of Civilization, Culture and Social Order over the Centuries
B. Sense the development of Technology and its impact on the Society's Culture and vice-versa, as well as the concept of Globalization and its effects.
C. Realize the process of Industrialization and Urbanization, their positive and negative effects, like social problems, etc.

Syllabus Contents:

Introduction:
The meaning of Humanities and its scope. The importance of Humanities in Society in general and for Engineers in particular.

Social Science and Development:
Development of Human Civilization over the centuries – Society and the place of man in society – Culture and its meaning -- Process of social and cultural change in modern India -- Development of technology, Industrialization and Urbanization -- Impact of development of Science and Technology on culture and civilization -- Urban Sociology and Industrial Sociology – the meaning of Social Responsibility and Corporate Social Responsibility – Engineers' role in value formation and their effects on society.

Introduction to Industrial Psychology:
The inevitability of Social Change and its effects -- Social problems resulting from economic development and social change (e.g. overpopulated cities, no skilled farmers, unemployment, loss of skills due to automation, addictions and abuses, illiteracy, too much cash flow, stressful working schedules, nuclear families etc.) – Job Satisfaction -- The meaning of Motivation as a means to manage the effects of change – Various theories of Motivation and their applications at the workplace (e.g. Maslow's Hierarchy of Needs, McGregor's Theory X and Y, The Hawthorne Experiments, etc.) – The need to enrich jobs through skill and versatility enhancement – Ergonomics as a link between Engineering and Psychology

References:

1. Jude Paramjit S. and Sharma Satish K., "Ed: Dimensions of Social Change"
2. Raman Sharma, "Social Changes in India"
3. Singh Narendar, "Industrial Psychology", Tata McGraw-Hill, New Delhi, 2011
4. Ram Ahuja, "Social Problems in India"

(MLC) Intellectual Property Rights

Teaching Scheme
Lectures: 1 hr/week

Examination Scheme
Marks: 100

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

A. Understand that today's world is controlled by Computer, Information Technology, but tomorrow's world will be ruled by ideas, concept, and creativity.
B. Understand that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
C. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Syllabus Contents:

Introduction

- Nature of Intellectual Property: Patents, Designs, Trademarks and Copyright. Process of Patenting and Development: Technological research, Innovation, Patenting, Development.

International Scenario

- International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Patent Rights

- Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

New Developments in IPR

- Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge, Case Studies.

References:

1. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd , 2007
2. Mayall , "Industrial Design", McGraw Hill
3. Niebel , "Product Design", McGraw Hill
4. Asimov , "Introduction to Design", Prentice Hall
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", Aspen Publishers, 6th Edition.
6. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand.

(LLC) Liberal Learning Course

Teaching Scheme
Contact Period: 1 hr/week

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

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

A. Learn new topics from various disciplines without any structured teaching or tutoring
B. Understand qualitative attributes of a good learner
C. Understand quantitative measurements of learning approaches and learning styles
D. Understand various sources and avenues to harvest/gather information
E. Assess yourself at various stages of learning

Course Features:

- 10 Areas, Sub areas in each
- Voluntary selection
- Areas (Sub areas):
    1. Agriculture (Landscaping, Farming, etc.)
    2. Business (Management, Entrepreneurship, etc.)
    3. Defense (Study about functioning of Armed Forces)
    4. Education (Education system, Policies, Importance, etc.)
    5. Fine Arts (Painting, Sculpting, Sketching, etc.)
    6. Linguistics
    7. Medicine and Health (Diseases, Remedies, Nutrition, Dietetics, etc.)
    8. Performing Arts (Music, Dance, Instruments, Drama, etc.)
    9. Philosophy
    10. Social Sciences (History, Political Sc., Archeology, Geography, Civics, Economics, etc.)

Evaluation:

- **T1:** A brief format about your reason for selecting the area, sub area, topic and a list of 5 questions (20 marks)
- **T2:** Identify and meet an expert (in or outside college) in your choice of topic and give a write up about their ideas regarding your topic (video /audio recording of your conversation permitted (20 marks)
- **ESE:** Presentation in the form of PPT, demonstration, performance, charts, etc. in front of everyone involved in your sub area and one external expert (60 marks)

Resources:

- Expert (s), Books, Texts, Newspaper, Magazines, Research Papers, Journal, Discussion with peers or faculty, Internet, etc.

(Dissertation) Dissertation Phase – I

Teaching Scheme	Examination Scheme
--	Marks: 100 each

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

A. Conceive a problem statement either from rigorous literature survey or from the requirements raised by external entity.
B. Analyze the problem critically
C. Write document eport.
D. Present the work done.

Guidelines:

As per the AICTE directives, the dissertation is a yearlong activity, to be carried out and evaluated in two phases i.e. Phase – I: July to December and Phase – II: January to June.

The dissertation may be carried out preferably in-house i.e. department's laboratories and centers OR in industry allotted through department's T & P coordinator.

After multiple interactions with guide and based on comprehensive literature survey, the student shall identify the domain and define dissertation objectives. The referred literature should preferably include IEEE/IET/IETE/Springer/Science Direct/ACM journals in the domain area. In case of Industry sponsored projects, the relevant application notes, while papers, product catalogues should be referred and reported.

Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and phase wise work distribution, and submit the proposal within a month from the date of registration.

Phase – I deliverables: A document report comprising of summary of literature survey, detailed objectives, project specifications, paper and/or computer aided design, proof of concept/functionality, part results, A record of continuous progress.

Phase – I evaluation: A committee comprising of guides of respective specialization shall assess the progress/performance of the student based on report, presentation and Q & A. In case of unsatisfactory performance, committee may recommend repeating the phase-I work.

(Dissertation) Dissertation Phase –II

Teaching Scheme	Examination Scheme
--	Marks: 100 each

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

A. Design, implement and test the prototype/algorithm in order to solve the conceived problem.
B. Interpret and analyze the findings.
C. Write Project report.
D. Present the work done.
E. Publish the research work in journals/conferences of repute contributing to growth of technology in the domain.

Guidelines:

As per the AICTE directives, the dissertation is a yearlong activity, to be carried out and evaluated in two phases i.e. Phase – I: July to December and Phase – II: January to June.

The dissertation may be carried out preferably in-house i.e. department's laboratories and centers OR in industry allotted through department's T & P coordinator.

After multiple interactions with guide and based on comprehensive literature survey, the student shall identify the domain and define dissertation objectives. The referred literature should preferably include IEEE/IET/IETE/Springer/Science Direct/ACM journals in the domain area. In case of Industry sponsored projects, the relevant application notes, while papers, product catalogues should be referred and reported.

Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and phase wise work distribution, and submit the proposal within a month from the date of registration.

During phase – II, student is expected to exert on design, development and testing of the proposed work as per the schedule. Accomplished results/contributions/innovations should be published in terms of research papers in reputed journals and reviewed focused conferences OR IP/Patents.

Phase – II deliverables: A dissertation report as per the specified format, developed system in the form of hardware and/or software, A record of continuous progress.

Phase – II evaluation: Guide along with appointed external examiner shall assess the progress/performance of the student based on report, presentation and Q & A. In case of unsatisfactory performance, committee may recommend for extension or repeating the work.