SCHEME OF COURSE WORK

Course Details:

Course Title	**:Digital Control Systems**		
Course Code	**: 13EE2204**	**L T P C**	**:4 1 0 3**
Program:	**: M.Tech.**		
Specialization:	**: Power Electronics and Drives**		
Semester	**:I Sem**		
Prerequisites	**:Control Systems**		
Courses to which it is a prerequisite	**:ADCS**		

Course Outcomes (COs):

1	This course provides a foundation in discrete-time linear control system theory. To equip the students with the basic knowledge of A/D and D/A conversion, To understand the basics of Z- Transform
2	Analyze, design, and synthesize digital control systems using transform techniques (root locus and frequency response) and state-space methods (pole-assignment and state estimation). To understand the basic concepts of State Space Techniques.
3	This course provides ability to study the stability analysis of digital control system
4	Evaluating and setting the necessary specifications for analog systems that are to be controlled by digital computing devices, Designing digital devices to satisfy given specifications and to achieve desired system-behavior
5	To gain the basic knowledge of digital simulation and DSP Processors. Understanding the Basic Concepts of Microprocessor control of control systems and custom designed chips like Galil DMC-105.

Program Outcomes (POs):

1	Be a part of competent workforce in the area of Static Power Electronics Converters and power electronic converter fed electrical drives and power quality issues .
2	Apply soft computing techniques for Power Electronic Systems and Electric Drives.
3	Understand large scale Power Electronic Converter Systems, Electric Drives and issues involved through modeling, analysis and simulation.
4	Apply present day techniques and tools to solve Power electronic and electric drives problems relevant to india and other countries
5	To gain necessary skills in using state-of-the-art simulation tools such as PLEXIM, SABER, OPAL-RT Lab, dSPACE, MULTISIM , LABVIEW and other Tools for analysis , design and trouble shooting of power electronics converters and various Electric drives .
6	Collaborate with industries on problems of relevance to them while planning/organizing graduate dissertations towards expanding sphere of interaction..
7	Improve soft skills of students through seminars and organization of technology workshops, writing research/project reports as a part of graduate education.
8	Encourage life-long learning through professional bodies (such as IEEE. Institute of Engineers (India) ,etc)

9	Imbibe social responsibilities and ethical practices towards creating a work force for national growth

Course Outcome Versus **Program Outcomes:**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO-1			M	S					
CO-2			S	M					
CO-3				M			S		
CO-4			M	S					
CO-5			M	M		S			

S - Strongly correlated, *M* - *Moderately* correlated, *Blank* - *No correlation*

Assessment Methods:	Assignment / Quiz / Seminar / Case Study / Mid-Test / End Exam

Teaching-Learning and Evaluation

Week	TOPIC / CONTENTS	Course Outcomes	**Sample questions**	TEACHING-LEARNING STRATEGY	Assessment Method & Schedule
1	Introduction, digital signals and coding, Data conversion and quantization, Sample and hold devices, sampling period considerations, Mathematical Modeling of the Sampling Process	CO-1	Mathematical modeling of Sampling derivation	▫ Lecture ▫ Problem solving	Assignment (Week 2 - 4)
2	Sampling Theorem, Mathematical Modeling of Sampling by Convolution Integral, Flap-Top Approximation of Finite Pulse width Sampling, Data Reconstruction and Filtering of Sampling Signals, Zero-Order Hold, First Order Hold, Polygonal Hold and Slewer Order Hold	CO-1	Different types of Hold devices	▫ Lecture ▫ Problem solving	Mid-Test 1 (Week 9)
3	Introduction, Linear difference equations, pulse response, Z – transforms, Theorems of Z – Transforms, The inverse Z – transforms, Modified Z- Transforms. Introduction, The Pulse Transfer Function and the Z-Transfer Function,	CO-1	Z transforms	▫ Lecture ▫ Problem solving	Quiz (Week 2 - 4)
4	Pulse Transfer Function of the Zero-Order Hold and the Relation between G(s) and G(z), Closed loop systems- characteristic Equation, Causality and Physical Reliability, Sampled Signal Flow Graph.	CO-1	Sampled signal flow graphs	▫ Lecture Problem solving	
5	State Space Representation of discrete time systems, Pulse Transfer Function Matrix solving discrete time state space equations, State transition matrix and it's Properties, Methods for Computation of State Transition Matrix,	CO-2	State space models	▫ Lecture Problem solving	
6	Discretization of continuous time state,	CO-2	Controllability and observability	▫ Lecture	

	space equations, Concepts of Controllability and Observability			Problem solving	
7	Tests for controllability and Observability, Duality between Controllability and Observability, Controllability and Observability conditions for Pulse Transfer Function.	CO-2	Controllability and Observability conditions for Pulse Transfer Function.	▫ Lecture Problem solving	
8	Stability Analysis of closed loop systems in the Z-Plane, Jury stability test	CO-3	Stability Analysis		
9					
10	Stability Analysis by use of the Bilinear Transformation and Routh Stability criterion.,	CO-3	Bilinear Transformation	▫ Lecture ▫ Problem solving	Mid-Test 2 (Week 18)
11	Stability analysis using Liapunov theorems.	CO-3	Stability analysis using Liapunov theorems.	▫ Lecture Problem solving	Assignment (Week 11-13)
12	Introduction, Cascade Compensation by Continuous-Data Controllers,	CO-4	Compensation	▫ Lecture Problem solving	Quiz (Week 12 -1 4)
13	Design of Continuous-Data Controllers with Equivalent Digital Controllers	CO-4	Design of digital controllers	▫ Lecture Problem solving	
14	Digital Controllers, Design of Digital Control Systems with Digital Controllers through bilinear transformation.	CO-4	Design of digital controllers through bilinear transformation	▫ Lecture Problem solving	
15	Introduction, Digital Simulation- Digital Modeling with Sample and Hold Devices, State Variable Formulation, Numerical Integration, Rectangular Integration	CO-5	Digital simulation	▫ Lecture Problem solving	Assignment (Week 15)
16	Frequency Domain Characteristics-Frequency Warping, Frequency Prewarping. Introduction, Microprocessor Control of Control Systems,	CO-5	Microprocessor control of control systems	▫ Lecture Problem solving	
17	Single-Board Controllers with Custom-Designed Chips, The Galil DMC-105 Board, Digital Signal Processors- The Texas Instruments TMS320 DSP's, Development Systems and Support Tools.	CO-5	Dsp chips	▫ Lecture Problem solving	
18	Mid-Test 2				
19/20	END EXAM				

Model Question Paper

UNIT-I

1(a) Discuss frequency domain characteristics of the Zero order hold? (6 Marks)

(b) Explain briefly the mathematical modelling of sampling process? (6 Marks)

OR

2(a) Find y(k) for k>1 using Z-Transforms for the given difference equation with initial Conditions y(0) = 0, y(1) = 0?

$$y(k+2) + 0.5\, y(k+1) + 0.06y(k) = -(0.5)^{k+1}$$ (5 Marks)

(b) Realize the system given as y(n) -5/6 y(n-1) +1/6 y(n-2) = x(n) +2x(n-1) using Z-transform with minimum number of delay unit, assume initial conditions are zero? (7 Marks)

UNIT-II

3(a) A discrete time system is described by the difference equation y(k+3) +5y(k+2) +7y(k+1) +3y(k) = r(k+1) + 2r(k). Obtain the state model of the system in (i) controllable canonical form and (ii) Jordan canonical form. (8 Marks)

(b) Evaluate the system matrix "F' of the discrete time system corresponding to continuous time system with System matrix A=$\begin{bmatrix} 0 & 1 \\ 0 & -1 \end{bmatrix}$ (4Marks)

OR

4(a) Find the state space representation in the
(i) Controllable canonical form
(ii) Observable canonical form for the system with transfer function

$$\frac{y(z)}{u(z)} = \frac{z+1}{z^2+1.3z+0.4}$$ (8 Marks)

(b) Check whether the system represented by

x (k+1) = $\begin{bmatrix} -3 & 1 & 1 \\ -1 & 0 & 1 \\ 0 & 0 & 1 \end{bmatrix}$x(k) + $\begin{bmatrix} 0 & 1 \\ 0 & 0 \\ 2 & 1 \end{bmatrix}$u(k) ; y(k) = $\begin{bmatrix} 0 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix}$ x(k) is observable or not?

(4Marks)

UNIT-III

5(a) Consider the discrete-time unity feedback control system (with sampling period T=1Sec) whose open loop transfer function is given by

$G(z) = \frac{k(0.3679z+0.2642)}{(z-0.3679)(z-1)}$. Determine the range of gain K for stability by using Jury's stability test? (7 Marks)

(b) Consider the characteristic polynomial $\Delta(z) = 2z^4 + 7z^3 + 10z^2 + 4z + 1 = 0$ determine the stability of the system. (5 Marks)

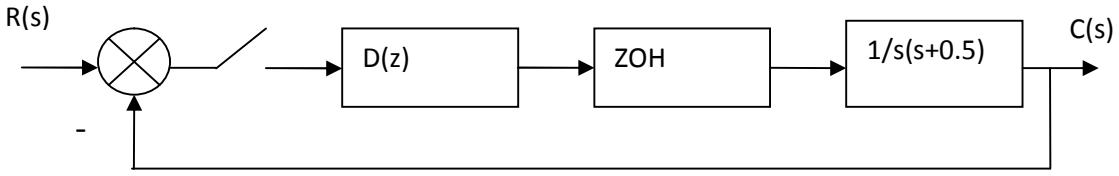
OR

6(a) write short notes on the stability in the sense of Lyapunov? (4 Marks)

(b) Given $f(z) = z^4 - 1.2z^3 + 0.07z^2 + 0.3z - 0.08 = 0$. Check the stability of the system by jury's stability test and verify by bilinear transformation method? (8 Marks)

UNIT-IV

7. Consider the feedback control system the plant transfer function is G(s) = k/s(s+0.5)

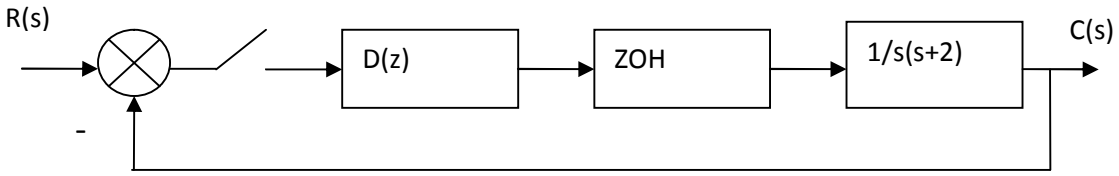


Design a compensator to satisfy the following specifications.

(i) $K_v \geq 4$ (ii) Phase margin = 50^0 (iii) GM $\geq$ 10dB assume T=0.1 sec. (12 Marks)

OR

8. Consider the feedback control system the plant transfer function is G(s) = k/s(s+2)



Design a lag compensator to satisfy the following specifications.

(i) $K_v \geq 4$ (ii) Phase margin = 40^0 (iii) GM $\geq$ 10dB assume T=0.4 sec. (12 Marks)

UNIT-V

9(a) Write a short note on frequency warping and prewarping? (6 Marks)

(b) Explain in detail digital simulation through ample and hold devices? (6 Marks)

OR

10 (a) Write a short note on single board controllers with custom designed chips? (6 Marks)

(b) With a neat diagram explain microprocessor control of control systems? (6 Marks)