GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Subject Code: ME02000701

Subject Name: Digital Control of Power Electronics System

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Elective

Prerequisite	Control systems, Power Electronics
Rationale:	In the modern world, every application in our life has become digital. Most of the industrial applications are digitally controlled. In this context, the role of digital control theories and its application to model, analyze and control Power Electronics converters plays a major role. This makes, study of this subject an important part of curriculum of PG level Power Electronics Engineering.

Course Outcome:

After Completion of the Course, the student will be able to:

No	Course Outcomes
01	Prepare discrete time mathematical model of power electronic system
02	Simulate discrete time power electronic system
03	Analyze power electronic system in discrete time.
04	Decide appropriate discrete time controller for power electronic system.

Teaching and Examination Scheme:

Teaching Scheme (in			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Tutorial / Practical		
				ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction:** Review of control systems, Transfer function of system, Stability concepts, signals, digital signals, basic discrete time signals, discretizing continuous time signals, Shannon's sampling theorem, sample and hold, 1st order hold, 2nd order hold, converting signals into digital form using ADC. Stability analysis in discrete time: Z transformation and Z plane, converting TF into discrete time TF, Stability in Z plane, Stability test etc.	6	20
2	**Controllers:** P, PI, PID controllers in discrete time, advanced control methods, application to power electronic systems.	6	10

3.	**Mathematical Modeling and Control of Controlled Rectifier:** Modelling of single-phase half-wave-controlled rectifier, single-phase full-wave controlled rectifier, three-phase half-wave-controlled rectifier, three-phase full-wave controlled rectifier, double anti-star half-wave-controlled rectifier with balanced inductor, delta-star three-phase full-wave controlled rectifier etc., Digital control of controlled rectifier.	8	20
4.	**Mathematical Modeling and Control of Inverter:** Modelling of Single-phase half-bridge voltage source inverter (VSI), Single-phase full-bridge VSI, Three-phase full-bridge VSI, three-phase full-bridge current source inverter (CSI), Multistage PWM inverters., Digital control of these inverter circuits	9	20
5.	**Mathematical Modeling and Control of DC/DC Converter:** Modelling of Forward converter, Push–Pull converter, Fly-back converter, Half-Bridge converter, Bridge converter, zeta converter etc., Digital control of these converters	9	20
6.	Mathematical Modeling and Control of various AC/AC Converter (Cyclo-converters)	7	10
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
40	**20**	**20**	**20**	**0**	**0**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Krzysztof Sozański , "Digital Signal Processing in Power Electronics Control Circuits", Springer
2. Fang Lin Luo, Hong Ye and Muhammad Rashid, "Digital Power Electronics and Applications", Elseviear
3. Edited by Miguel Castilla, "Control Circuits in Power Electronics", IET POWER AND ENERGY SERIES 72

(b) Open-source software and website:

1. https://nptel.ac.in/

Suggested Course Practical List:

The following list is for suggestions only. The subject teacher can change the list according to availability of resources.

1. Study of modelling and discrete time control of various rectifier circuits through simulation.
2. Study of modelling and discrete time control of various inverter circuits through simulation.
3. Study of modelling and discrete time control of various DC/DC converter circuits through simulation.
4. Study of modelling and discrete time control of various AC/AC converter circuits through simulation.
5. A small simulation of a digitally controlled power electronic system.

List of Laboratory/Learning Resources

Required:

PC/Laptop with installed MATLAB/ similar software, power converter hardware etc.

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