GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Applied Instrumentation

Subject Code : ME02067071

Subject Name : Optimal Control

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

Prerequisite:	Nonlinear and digital control, Control system design, Process Control
Rationale:	This course helps to evaluate the control signals that satisfy some physical constraints and minimize or maximize some performance measure. Calculus of Variation as well as State Variable methods are discussed and reviewed. Pontryagin's maximum principle and dynamic programming to problems of optimal control theory. Interactive numerical techniques for finding optimal trajectories.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Understands the concept of optimization by means of problem formulation and define performance measures	UN
02	Apply dynamic programming	AP
03	Apply Calculus of variations.	AP
04	Analyse the system for tracking and regulatory optimization control	AN
05	Evaluate the system performance based on time and control efforts.	EL

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	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.	Mathematical preliminaries: Problem formulation – Mathematical model – Physical constraints - Performance measure Optimal control problem. Form of optimal control. Performance measures for optimal control problem. Selection a performance measure.	5	12
2.	Dynamic Programming – Optimal control law – Principle of optimality. An optimal control system. A recurrence relation of dynamic programming – computational procedure. Characteristics of dynamic programming solution. Hamilton – Jacobi – Bellman equation. Continuous linear regulator problems.	10	22
3.	Calculus of variations – Fundamental concepts. Functionals. Piecewise – smooth externals. Constrained extrema.	10	22
4.	Variational approach to optimal control problems – Necessary conditions for optimal control – Linear regulator problems. Linear tracking problems. Pontryagin's minimum principle and state inequality constraints.	10	22
5.	Minimum time problems – Minimum control – effort problems. Singular intervals in optimal control problems. Numerical determination of optimal trajectories – Two point boundary – value problems. Methods of steepest decent, variation of externals. Quasilinearization. Gradient projection algorithm.	10	22
	Total	**45**	**100**

References / Suggested Learning Resources:

(a) Books:

1. Donald E. Kirk, Optimal Control Theory: An Introduction, Prentice-Hall networks series, 1970.
2. Anderson and J.B. Moore, *Optimal Control: Linear Quadratic Methods*, Dover Publications, 2014.
3. F.L. Lewis, D. Vrabie and V. L. Syrmos, *Optimal Control*, 3rd edition, Wiley & Sons, 2012
4. Sage A. P, White .C. C, Optimum Systems Control, Second Edition, Prentice Hall, 1977.

(b) Open source software and website:

1. https://www.scilab.org/
2. https://archive.nptel.ac.in

Suggested Project List:

In the project assignment the students will be given the opportunity to focus on a topic in optimal control of their own choice of system. This may a topic related to their own research project.

List of Laboratory/Learning Resources Required:

Matlab, Scilab software

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