Semester-I Paper-4
ADAPTIVE & OPTIMAL CONTROL

Teaching scheme	**Examination scheme**
Lectures: 4 Hrs / Week	Theory: 100 Marks
Practical: 2 Hrs/ week	Term work**:** 25 Marks

Unit 1. (10 Hrs, 20 Marks)
Introduction to adaptive control, Effects of process variations, Adaptive control schemes, Adaptive control problem, Non-parametric identification, Step response method, Impulse response method, and Frequency response method.

Unit 2. (10 Hrs, 20 Marks)
Linear in parameter models, ARX, ARMAX, ARIMAX, Least square estimation, Recursive least square estimation, Extended least square estimation, Maximum likelihood estimation, Introduction to non-linear systems identification, Pseudo random binary sequence.
Self-tuning regulator: Deterministic in-direct self-tuning regulators, Deterministic direct self-tuning regulators, Introduction to stochastic self-tuning regulators, Stochastic indirect self-tuning regulator.

Unit 3. (10 Hrs, 20 Marks)
Model reference adaptive controller: The MIT rule, Lyapunov theory, Design of model reference adaptive controller using MIT rule and Lyapunov theory, Relation between model reference adaptive controller and self-tuning regulator.
Tuning of controllers and case studies: Design of gain scheduling controller - Auto-tuning of PID regulator, Stability analysis of adaptive controllers – Application of adaptive control in chemical reactor, distillation column and variable area tank system.

Unit 4. (10 Hrs, 20 Marks)
Statement of optimal control problem, Problem formulation and forms of optimal control, Performance measures for optimal control, Selection of performance measure, Various methods of optimization, Linear programming, Non-linear programming, Dynamic programming.

Unit 5. (10 Hrs, 20 Marks)
Principle of optimality, recurrent relation of dynamic programming for optimal control problem, Computational procedures for solving optimal control problems, Characteristics of dynamic programming solution, Hamilton Jacobi Bellman equation, Application to a continuous linear regulator problem.

References:

1. Adaptive Control, “Karl J. Astrom & Bjorn Wittenmark”, Pearson Education (Singapore), Second Edition, 2003.
2. System Identification,“C.H.A. Hsia”, Lexington books, 1974.
3. Chemical Process Control, “Stephanopoulis G”, Prentice Hall of India, New Delhi, 1990.
4. Optimal Control Theory – An introduction, “Donald E. Kirk”, Pearson Education, 1970.
5. Robust & Optimal Control, “Kemin Zbou, J.C. Doyle”, Pearson Education, 1996.
6. Modern Control System Theory, “M. Gopal”, New Age International Ltd.
7. Control System Design – The Optimal Approach, “B. Sarkar”, Wheeler Publishing, New Delhi, 1997.

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List of Experiments:

Term work shall consist of at least **eight** experiments based on above topics