

SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

**DEPARTMENT OF
ELECTRONICS AND INSTRUMENTATION ENGINEERING**

QUESTION BANK



VI SEMESTER

EI8071- ADAPTIVE CONTROL

Regulation – 2017

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Prepared by

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SUBJECT : EI8071- ADAPTIVE CONTROL

YEAR /SEM : III /VI

UNIT I

INTRODUCTION

Introduction to adaptive control – Effects of process variations – Adaptive control schemes – Adaptive control problem – Non-parametric identification – Step response method – Impulse response method – Frequency response method.

PART – A

Q. No	Questions	BT Level	Competence
1.	What is meant by conventional control?	BTL 2	Understand
2.	Define adaptive control.	BTL 1	Remember
3.	Compare conventional control and adaptive control.	BTL 5	Evaluate
4.	Draw the block diagram of an adaptive system.	BTL 1	Remember
5.	Develop the steps for constructing the adaptive controller for any system.	BTL 6	Create
6.	Point out the elements of the adaptive control system.	BTL 4	Analyze
7.	Why adaptive control is needed for a process?	BTL 4	Analyze
8.	Write the variables used in adaptive control.	BTL 1	Remember
9.	List the types of adaptive controller.	BTL 1	Remember
10.	Demonstrate briefly about gain scheduling adaptive controller.	BTL 3	Apply
11.	Draw the block diagram of Gain scheduling adaptive controller for a process.	BTL 1	Remember
12.	Describe about Model Reference adaptive systems.	BTL 2	Understand

13.	Construct the functional diagram of Model Reference adaptive systems.	BTL 2	Understand
14.	Summarize about self tuning regulator.	BTL 2	Understand
15.	Design the control equation used for the adjustment of gains in a state feedback.	BTL 6	Create
16.	Apply non parametric identification of system to a simple system and calculate system transfer function.	BTL 3	Apply
17.	List some methods of non parametric identification of system.	BTL 1	Remember
18.	Illustrate step response method of non parametric identification of system.	BTL 3	Apply
19.	Analyze about frequency response method of non parametric identification.	BTL 4	Analyze
20.	Compare step response method with impulse response method of non parametric identification of system.	BTL 5	Evaluate

PART – B

Q. No	Questions		BT Level	Competence
1.	Describe about the effects of process variation with an example? (13)		BTL 1	Remember
2.	(i)	Explain about the gain scheduling with neat block diagram. (8)	BTL 4	Analyze
	(ii)	Demonstrate the procedure to decide what type of control to be used for a process with diagram. (5)	BTL 3	Apply
3.	(i)	Describe about robust high gain system with neat diagram. (6)	BTL 1	Remember
	(ii)	Explain how Model reference adaptive system is used in process, explain with neat block diagram. (7)		
4.	(i)	Explain about Self tuning regulator with neat block diagram. (8)	BTL 4	Analyze
	(ii)	Explain about input error adaptive control. (5)		
5.	(i)	Demonstrate about input error adaptive control algorithm implementation with necessary diagram. (9)	BTL 3	Apply
	(ii)	Illustrate the need of adaptive observer? (4)		
6.	Design non parametric identification of a system by Impulse response method. (13)		BTL 6	Create
7.	Summarize various adaptive control schemes with neat diagram. (13)		BTL 5	Evaluate
8.	(i)	Describe about the Dual control type of adaptive control scheme with neat block diagram. (6)	BTL 1	Remember
	(ii)	Describe about parameter adaptation algorithm with neat diagram. (7)		

9.	(i)	Differentiate the single input and single output process equation for continuous and discrete system. (6)	BTL 4	Analyze
	(ii)	Analyze about the behaviour of flow control loop with PI control and non linear valve. (7)		
10.		Describe about Indirect adaptive controller with neat diagram and necessary equations. (13)	BTL 1	Remember
11.	(i)	Interpret about Non parametric identification by step response method. (5)	BTL 2	Understand
	(ii)	Describe about Adaptive control of MIMO systems decouplable by static state feedback. (8)		
12.	(i)	Interpret about Non parametric identification by frequency response method. (6)	BTL 2	Understand
	(ii)	Demonstrate about concentration control system with its equation. (7)	BTL 3	Apply
13.	(i)	Summarize about output error adaptive control algorithm implementation. (7)	BTL 2	Understand
	(ii)	Explain about the Expert adaptive control systems. (6)	BTL 4	Analyze
14.		Describe about any two Non parametric identification of models with necessary equation. (13)	BTL 2	Understand

PART C

Q. No	Questions		BT Level	Competence
1.	(i)	Evaluate the effect of process variations in flow control loop with non linear valve and in concentration control systems. (9)	BTL 5	Evaluate
	(ii)	State the procedure for the selection of control to be used for a process with diagram. (6)		
2.		Design the different type of adaptive control system with neat diagrams. (15)	BTL 6	Create
3.	(i)	Illustrate the Indirect adaptive controller with neat diagram and necessary equations. (10)	BTL 5	Evaluate
	(ii)	Develop any one Industrial adaptive control systems. (5)	BTL 6	Create
4.		Design the different types of Non parametric identification of system models with necessary diagrams and equation. (15)	BTL 5	Evaluate

UNIT-II

PARAMETRIC IDENTIFICATION

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.

PART – A

Q. No	Questions	BT Level	Competence
1.	What is mean by regressive estimation?	BTL 1	Remember
2.	Define Recursive Least-Squares Algorithm.	BTL 1	Remember
3.	Why the regressive methods are more important in adaptive schemes?	BTL 2	Understand
4.	Evaluate the equation for weighted least squares criteria.	BTL 5	Evaluate
5.	Draw the schematic representation of ARX structure.	BTL 2	Understand
6.	Apply ARMAX model to a first order system.	BTL 3	Apply
7.	List the features of ARMAX model.	BTL 1	Remember
8.	Compare ARMAX model with ARIMAX model.	BTL 4	Analyze
9.	Describe briefly about system identification?	BTL 1	Remember
10.	Apply Multivariable identification to model any simple system.	BTL 3	Apply
11.	Develop the relationship between least squares algorithm recursive lest squares algorithm.	BTL 6	Create
12.	Give the application for industrial use of system identification.	BTL 2	Understand
13.	Differentiate linear and non linear model.	BTL 4	Analyze
14.	Compare deterministic and Stochastic model.	BTL 4	Analyze
15.	List the different estimation method used in adaptive system.	BTL 1	Remember
16.	Draw the block diagram of a least squares estimator based on the output error.	BTL 1	Remember
17.	Assess stochastic approximation algorithm.	BTL 5	Evaluate
18.	Demonstrate briefly about finite impulse response models.	BTL 3	Apply
19.	Design the memory of the estimator in terms of forgetting factor.	BTL 6	Create
20.	Illustrate the output representation of Pseudo random binary sequence.	BTL 3	Apply

PART B

Q. No	Questions	BT Level	Competence
1.	(i) Deduce the general ARX model with necessary equations. (8)	BTL 5	Evaluate
	(ii) Test the ARX model for an application. (5)		
2.	(i) Describe about ARMAX model with necessary equations. (8)	BTL 1	Remember
	(ii) Define output error model and briefly explain. (5)		
3.	Summarize about ARIMAX model with necessary equations. (13)	BTL 2	Understand

4.	(i)	Explain about least square and regression models. (8)	BTL 4	Analyze
	(ii)	Analyze how least square method can be used to estimate the parameters in finite impulse response models. (5)		
5.		Design the least square estimate for the general loss function. (13)	BTL 6	create
6.		Demonstrate least square estimation of static system with necessary equations. (13)	BTL 3	Apply
7.	(i)	Summarize about least square and regression models for a second order system with necessary equations. (7)	BTL 2	Understand
	(ii)	Describe about recursive least square estimation of static system with necessary equations. (6)		
8.	(i)	Describe about Continuous time least square estimation with necessary equations. (6)	BTL 1	Remember
	(ii)	Examine how least square method can be used to estimate the non linear models. (7)		
9.	(i)	Describe about Extended least square estimation of static system with necessary equations. (10)	BTL 1	Remember
	(ii)	List the statistical properties of the least square function. (3)		
10.		Demonstrate about the non linear system identification with required equations. (13)	BTL 3	Apply
11.		Describe about the estimating parameters in dynamical systems. (13)	BTL 1	Remember
12.	(i)	Discuss how least square can be applied to continuous time transfer functions. (7)	BTL 2	Understand
	(ii)	Interpret about the loss of identifiability due to feedback. (6)		
13.		Explain Recursive maximum likelihood estimation with necessary equations. (13)	BTL 4	Analyze
14.		Analyze about the Selection of Pseudo random binary sequence with necessary equations. (13)	BTL 4	Analyze

PART – C

Q.No	Questions	BT Level	Competence
1.	Design ARX, ARMAX and ARIMAX models of parametric identification of system. (15)	BTL 6	create
2.	Evaluate the various Estimating parameters in dynamical systems with necessary equations. (15)	BTL 5	Evaluate
3.	Design the Structure of Recursive Parameter Estimation Algorithms with necessary diagram and equations. (15)	BTL 6	create
4.	Design the Recursive identification method on the whitening of the prediction error with necessary equations. (15)	BTL 6	create

UNIT-III

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.

PART A

Q.No	Questions	BT Level	Competence
1.	Draw the block diagram of self tuning regulator.	BTL1	Remember
2.	Define certainty equivalence principle.	BTL2	Understand
3.	Analyze why Indirect method self tuning is called as explicit self tuning control.	BTL4	Analyze
4.	Describe briefly about pole placement design of self tuning controller.	BTL1	Remember
5.	Assess that when perfect model following is achieved in a self tuning regulator.	BTL 5	Evaluate
6.	Design the condition to be satisfied for perfect model following?	BTL6	Create
7.	Define self tuning controller.	BTL1	Remember
8.	What is meant by minimum degree pole placement?	BTL2	Understand
9.	Deduce the control law for minimum degree pole placement.	BTL2	Understand
10.	Demonstrate briefly about self tuning regulators.	BTL 3	Apply
11.	State indirect self tuning regulator.	BTL1	Remember
12.	Compare hybrid self tuner with conventional self tuner.	BTL4	Analyze
13.	Create the control law for linear quadratic Gaussian controller.	BTL 6	create
14.	Demonstrate briefly about minimum variance controller.	BTL 3	Apply
15.	Describe briefly about moving average controller.	BTL1	Remember
16.	Write briefly about generalized minimum variance controller.	BTL2	Understand
17.	Summarize linear quadratic Gaussian self tuning regulator.	BTL2	Understand
18.	Point out the advantages of having direct self tuner with integral action?	BTL5	Evaluate
19.	Define stochastic self tuning regulators.	BTL1	Remember
20.	Demonstrate briefly unification of direct self –tuning regulators?	BTL3	Apply

Q.No	PART B			BT Level	Competence
1.	(i)	With basic block diagram demonstrate the self tuning regulator. (9)	BTL1	Remember	
	(ii)	Describe about model following and give its condition. (4)			
2.	Demonstrate about pole placement design with necessary equations. (13)			BTL3	Apply
3.	(i)	Analyze how a pole placement can be interpreted as a Model following design. (7)	BTL4	Analyze	
	(ii)	Explain the steps required to perform Minimum degree pole placement. (6)	BTL4	Analyze	
4.	(i)	Explain about indirect self tuning regulator with necessary equations. (8)	BTL4	Analyze	
	(ii)	Point out the significance of indirect self tuner. (5)	BTL4	Analyze	
5.	(i)	Design continuous time self tuners with necessary equations. (7)	BLT6	Create	
	(ii)	Develop the suitable continuous time self tuners for the function $G(S)=S/S(S+a)$. (6)	BLT6	Create	
6.	Describe about direct self tuning regulators with necessary equations and also give the algorithm for direct self tuner. (13)			BTL1	Remember
7.	(i)	Assess self tuning regulator that combines feedback and feed forward controller. (6)	BTL4	Evaluate	
	(ii)	Assess the Direct self tuning regulator for Non minimum phase systems. (7)			
8.	(i)	Recall hybrid self tuner and give the algorithm for hybrid self tuner. (6)	BTL1	Remember	
	(ii)	Describe about adaptive predictive control with necessary equations. (7)			
9.	Summarize about direct self tuner with integral action with necessary equations. (13)			BTL2	Understand
10.	Analyze about modified Pole placement design procedure by taking disturbance in to account and also describe about the modifications of its estimator. (13)			BTL4	Analyze
11.	Describe about the design of minimum variance controllers for linear stochastic systems with necessary equations. (13)			BTL2	Understand
12.	Interpret about the design of moving average controllers for linear stochastic systems with necessary equations. (13)			BTL2	Understand
13.	Explain about basic direct self tuning algorithm and obtain a control law for direct minimum variance self tuning regulator for any process. (13)			BTL1	Remember
14.	(i)	Demonstrate about stochastic indirect self tuning regulator for any process. (9)	BTL3	Apply	
	(ii)	Illustrate about self tuning feed forward control. (4)			

PART C			
Q.No	Questions		BT Level Competence
1.	Design self tuning regulator by pole placement design and also give the algorithm for minimum degree pole placement. . (15)		BLT6 Create
2.	(i)	Demonstrate Indirect self tuning regulators and also give algorithm using RLS and MDPP. (9)	BTL4 Evaluate
	(ii)	Summarize about continuous time self tuners with necessary equations.(6)	
3.	Illustrate about the adaptive predictive control and give output prediction and constant future control with necessary equations. (15)		BTL4 Evaluate
4.	Design the algorithm for Generalized self tuning algorithm and also give details about self tuning feed forward control. (15)		BLT6 Create

UNIT-IV			
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.			
PART –A			
Q.No	Questions		BT Level Competence
1.	Draw the block diagram of model reference adaptive system.		BTL 2 Understand
2.	Define model reference control.		BTL 1 Remember
3.	Define MIT rule.		BTL 1 Remember
4.	Design the loss function used in MIT rule.		BTL 6 Create
5.	Interpret about sign sign algorithm.		BTL 3 Apply
6.	Assess the need of normalized MIT rule.		BTL 5 Evaluate
7.	Demonstrate briefly about MRAC.		BTL 3 Apply
8.	Create the parameter equation used for the determination of the adaptation gain for the adaptive system.		BTL 6 Create
9.	Summarize briefly about positive definite and semi definite functions.		BTL 2 Understand
10.	Analyze any two practical significance of the adaptation gain.		BTL 4 Analyze
11.	Define Lyapunov's theory for time invariant system.		BTL 1 Remember
12.	Define Lyapunov's theory for time varying system.		BTL 1 Remember
13.	What is meant by uniform Lyapunov's stability?		BTL 1 Remember
14.	Draw the block diagram of the adaptive systems for feed forward gain compensation obtained by MIT rule.		BTL 1 Remember

15.	Give the application of Back stepping control law.	BTL 2	Understand
16.	Analyze about adaptive back stepping control law.	BTL 4	Analyze
17.	Differentiate MRAS and STR.	BTL 5	Evaluate
18.	Define model reference control.	BTL 1	Remember
19.	Describe briefly about Feedback linearization	BTL 2	Understand
20.	Apply adaptive back stepping control to a first order system and illustrate its output.	BTL 3	Apply

PART – B

Q.No	Questions		BT Level	Competence
1.	(i)	Analyze the general MIT rule used for adaptive controller with necessary equations. (7)	BTL 4	Analyze
	(ii)	Obtain the Model reference adaptive controller for adjusting the feed forward gain using MIT rule. (6)		
2.	(i)	Deduce the Model reference adaptive controller for first order process using MIT rule and explain with neat diagram. (8)	BTL 5	Evaluate
	(ii)	Explain about error and Parameter convergence with necessary equations. (5)		
3.	(i)	Describe about the determination of adaptation gain in adaptive system. (7)	BTL 1	Remember
	(ii)	Describe about error and parameter convergence in model reference adaptive systems. (6)		
4.	(i)	Summarize about the Lyapunov's theory for time invariant systems with necessary equations. (10)	BTL 2	Understand
	(ii)	What is positive definite and semi definite function? (3)		
5.	(i)	Demonstrate about the Lyapunov's function for linear system. (9)	BTL 3	Apply
	(ii)	Illustrate about normalised MIT rule with necessary equation. (4)		
6.	Infer about stochastic indirect self tuning regulator with necessary equations. (13)		BTL 4	Analyze
7.	(i)	Explain the Lyapunov's theory for time varying systems with necessary equations. (10)	BTL 4	Analyze
	(ii)	Explain Uniform Lyapunov's stability. (3)		
8.	Design a First order reference adaptive controller based on stability theory with necessary equations. (13)		BTL 6	Create

9.	(i)	Interpret how Lyapunov's theory can be used to derive stable MRAS for general linear systems with necessary equations. (10)	BTL 2	Understand
	(ii)	Summarize about bounded input, bounded output stability. (3)		
10.	Interpret Lyapunov's theory to derive the parameter adjustment laws for the problem of adjusting a feed forward gain. (13)		BTL 2	Understand
11.	Describe the relation between the MRAS and self tuning regulator with necessary equations. (13)		BTL 1	Remember
12.	Examine about feedback linearization with necessary equations. (13)		BTL 1	Remember
13.	Demonstrate about stabilization by back stepping with necessary equations. (13)		BTL 3	Apply
14.	Summarize about stabilization by Adaptive back stepping with necessary equations. (13)		BTL 1	Remember

PART – C

Q .No	Questions	BT Level	Competence
1.	Create Model reference adaptive controller for adjusting the feed forward gain using MIT rule and also obtain the Model reference adaptive controller for first order process using MIT rule. (15)	BTL 5	Evaluate
2.	Design a First order reference adaptive controller based on lyapunov's stability theory. (15)	BTL 6	Create
3.	Develop the adaptive feedback linearization for general system with necessary equations. (15)	BTL 6	Create
4.	Compose about general adaptive stabilization with back stepping with necessary equations. (15)	BTL 6	Create

UNIT-V

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.

PART – A

Q. No	Questions	BT Level	Competence
1.	What is meant by gain scheduling?	BTL 1	Remember
2.	Draw the block diagram of a system in which influences of parameter variations are reduced by gain scheduling.	BTL 1	Remember

3.	List the drawbacks of gain scheduling.	BTL 1	Remember
4.	Illustrate about controller turning for first order system.	BTL 3	Apply
5.	Describe briefly about reaction curve?	BTL 2	Understand
6.	Assess that what performance criterion should be used for the selection and turning of Controller?	BTL 5	Evaluate
7.	Discuss briefly about non linear transformation.	BTL 2	Understand
8.	List the applications of gain scheduling.	BTL 1	Remember
9.	What is meant by pH control?	BTL 1	Remember
10.	Analyze the drawbacks of robust high gain feedback control.	BTL 3	Apply
11.	Compare Robust and adaptive control.	BTL 4	Analyze
12.	Assess any two auto tuning methods.	BTL 5	Evaluate
13.	Design the regulator parameter obtained by the Ziegler-Nichols step response method.	BTL 6	Create
14.	Create the regulator parameter obtained by the Ziegler-Nichols closed loop method.	BTL 6	Create
15.	Draw the block diagram of a relay auto-tuner.	BTL 2	Understand
16.	Write the equation for PID controller output.	BTL 2	Understand
17.	Draw the Chemical reactor control.	BTL 1	Remember
18.	Analyze how adaptive control is used in automobiles.	BTL 4	Analyze
19.	Demonstrate briefly about one button tuning?	BTL 3	Apply
20.	How multi variable control problems can be handled by adaptive controller.	BTL 4	Analyze

PART – B

Q.No	Questions		BT Level	Competence
1.	Describe about the principle of gain scheduling with neat block diagram explain with examples. (13)		BTL 1	Remember
2.	(i)	Describe about design of Gain Scheduling controllers for non linear actuator with block diagram and waveform. (9)	BTL 1	Remember
	(ii)	Describe how non linear transformation makes non linear controller to be interpreted as Gain scheduling controller. (4)		
3.	(i)	Perform non linear transformation of a pendulum and obtain a controller signal output. (9)	BTL 4	Analyze
	(ii)	Analyze briefly about auto tuning of cascaded tanks. (4)		
4.	Describe about the Non linear transformation of a second order system to attain a gain scheduling with a block diagram. (13)		BTL 1	Remember

5.	(i)	Describe about adaptive feed forward and gain scheduling in an oxygen trim controller with neat diagram. (6)	BTL 2	Understand
	(ii)	Interpret how adaptive feed forward and gain scheduling is used to Fuel Air control in a car engine with a neat diagram. (7)		
6.		Assess any two applications of Gain Scheduling with neat diagram. (13)	BTL 5	Evaluate
7.	(i)	Explain the transient response methods of tuning PID controllers. (4)	BTL 4	Analyze
	(ii)	Analyze the Ziegler-Nichols step response method to determine the parameters of a PID regulator. (9)		
8.	(i)	Demonstrate about the tuning of controller based on relay feedback with neat diagram. (7)	BTL 3	Apply
	(ii)	Illustrate about the Ziegler-Nichols closed loop method to determine the parameters of a PID regulator. (6)		
9.	(i)	Summarize about adaptive temperature control in a distillation column. (6)	BTL 2	Understand
	(ii)	Interpret about adaptive type Chemical reactor control with neat diagram. (7)		
10.	(i)	Explain about Adaptive type Pulp dryer control with schematic diagram. (7)	BTL 4	Analyze
	(ii)	Analyze about Adaptive type control of rolling mill in process industry. (6)		
11.	(i)	Describe about adaptive controller working on Pulp digester with neat diagram. (8)	BTL 1	Remember
	(ii)	Describe about adaptive controller used in automobile control. (5)		
12.	(i)	Demonstrate about adaptive controller working ship steering. (7)	BTL 3	Apply
	(ii)	Illustrate about adaptive controller used in Autopilot design. (6)		
13.		Design an adaptive control system used in dialysis system with its process dynamics and parameter estimation. (13)	BTL 6	Create
14.		Summarize about the application of adaptive control in variable area tank system with neat diagram. (13)	BTL 2	Understand

PART – C

Q.No	Questions	BT Level	Competence
1.	Design gain scheduling used in ship steering with diagram and necessary equations. (15)	BTL 6	Create

2.	Summarize about various techniques used in auto tuning of controller with necessary diagram. (15)		BTL 5	Evaluate
3.	(i)	Assess about stability problem in adaptive control. (8)	BTL 5	Evaluate
	(ii)	Summarize about Indirect adaptive control scheme with block diagram. (7)		
4.	Design an adaptive controller for (i) Chemical reactor (7) (ii) Distillation column (8) with necessary modelling.		BTL 6	Create

