ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABUS

CONTROL SYSTEMS

Department of Electrical and Electronics Engineering

M.Tech Two Year Degree Course

(Applicable for the batch admitted from 2014-15)

GUDLAVALLERU ENGINEERING COLLEGE

(An Autonomous Institute with Permanent Affiliation to JNTUK, Kakinada)

Seshadri Rao Knowledge Village

GUDLAVALLERU - 521 356, Krishna District, Andhra Pradesh

CONTENTS

M.Tech - Control Systems

ACADEMIC REGULATIONS

M.Tech - Control Systems

ACADEMIC REGULATIONS

1. Duration of the Program

The duration of the program is two academic years consisting of four semesters. However, a student is permitted to complete the course work of M.Tech program in the stipulated time frame of **FOUR** years from the date of joining.

2. Minimum Instruction Days

Each semester consists of a minimum of ninety instruction days.

3. Program Credits

Each specialization of the M.Tech programs is designed to have a total of 80 credits and the student shall have to complete the two year course work and earn all the 80 credits for the award of M.Tech Degree.

4. Attendance Regulations

4.1 A student shall be eligible to appear for End Semester Examinations if he acquires a minimum of 75% of attendance in aggregate of all the subjects.

4.2 Condoning of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester will be considered for genuine reasons such as medical grounds and participation in co-curricular and extra-curricular activities and shall be granted only after approval by a committee duly appointed by the college. Student should submit application for medical leave along with medical certificate from a registered medical practitioner within three days from reporting to the class work after the expiry of the medical leave. In case of participation in co-curricular and extra-curricular activities, either in the college or other colleges, students must take prior written permission from HoD concerned and should also submit the certificate of participation from the organizer of the event within three days after the completion of the event. Only such cases will be considered for condoning attendance shortage.

4.3 A student shall be eligible to claim for condonation of attendance shortage only once during the two years (four semesters) course work.

4.4 A student will not be promoted to the next semester unless he satisfies the attendance requirement of the current semester. He may seek re-admission for that semester when offered next.

4.5 Shortage of Attendance below 65% in aggregate shall in *NO* case be condoned.

4.6 Students whose shortage of attendance is not condoned in any semester are not eligible to take their end examination of that semester and their registration shall stand cancelled.

4.7 A fee stipulated by the college shall be payable towards condoning attendance shortage.

5. Examinations and Scheme of Evaluation

5.1 Theory Courses:

Each theory course shall be evaluated for a total of 100 marks, consisting of 40 marks for internal assessment and 60 marks for semester end examination.

***Internal Assessment*:**

i) Out of 40 marks for internal assessment, 20 marks are for continuous assessment in the form of assignment and seminar and 20 marks are based on two mid-term examinations.

ii) Of the 20 marks for continuous assessment, 10 marks each for assignment and seminar.

iii) Each mid-term examination is conducted for 40 marks with two hours duration. Each mid-term examination consists of four questions, each for 10 marks. All the questions need to be answered.

iv) Sum of the 75% marks of best scored mid-term examination and 25% marks of other mid-term examination are scaled down for 20 marks.

***External Assessment*:**

Semester End Examination will have 8 questions, each for 12 marks, out of which 5 questions are to be answered.

5.2 Laboratory Course:

i) For practical subjects the distribution shall be 40 marks for Internal Evaluation and 60 marks for the End-Examinations. There shall be continuous evaluation by the internal subject teacher during the semester for 40 internal marks. Of the 40 marks for internal, 30 marks shall be for day-to-day performance (20 marks for day-to-day evaluation and 10 marks for Record) and 10 marks for an internal laboratory test conducted towards the end of semester.

ii) Semester End examination shall be conducted by the teacher concerned and external examiner for 60 marks.

5.3 Seminar:

For seminar, a student under the supervision of a faculty member, shall collect the literature on an advanced topic related to his specialization and critically review the literature and submit it to the department in a report form two weeks before the end of the 3rd semester and shall make an oral presentation before the Departmental Review Committee consisting of the supervisor and a senior faculty member / Head of the Department. There

shall be an internal evaluation for 50 marks in the form of viva-voce examination and assessment of report and its presentation. There will be NO external evaluation.

If a candidate fails to secure the minimum marks prescribed for successful completion, he has to re-register by paying the prescribed fee at the beginning of 4th semester or subsequent semesters. He has to submit a fresh report two weeks before the end of that semester and appear for the evaluation by the committee.

5.4 Comprehensive Viva-Voce:

Comprehensive Viva-Voce examination is conducted for 50 marks at the end of third semester in all the subjects of first two semesters of the course by a committee consisting of two senior faculty members of the department. There will be NO external evaluation.

If a candidate fails to secure the minimum marks prescribed for successful completion, he has to re-register by paying the prescribed fee at the beginning of 4th semester or subsequent semesters and undergo Viva-Voce examination towards the end of that semester.

5.5 Project Work:

Every candidate shall be required to submit a thesis or dissertation on a topic approved by the Project Review Committee.

i) A Project Review Committee (PRC) shall be constituted for each specialization with Head of the Department as Chairman and two other senior faculty members.

ii) Registration of Project Work: A candidate who has been promoted to 3rd semester shall be eligible to register for the project work.

iii) The eligible candidate can choose his project supervisor and submit the title, objective, abstract and plan of action of the proposed project work to the department for approval by the PRC. The candidate whose proposal is approved by the PRC shall register for the project work. The minimum duration of project work will be 36 weeks from the date of registration.

iv) If a candidate wishes to change his supervisor or topic of the project, he can do so with the approval of the PRC. In case of such changes, the candidate has to register afresh.

v) There shall be three reviews on the progress of the project work by the PRC with an interval of 12 weeks. The candidate needs to submit a report on the progress of his work and present it before the PRC for assessment. The PRC may suggest for an extension of date of submission of dissertation if the progress of work is not satisfactory or absent himself for the review.

vi) A candidate who has passed all the theory, laboratory, seminar and comprehensive viva-voce examinations and shown satisfactory progress of project work is permitted to submit the dissertation after 36 weeks from the date of registration.

vii) If a candidate fails to submit the dissertation by the end of the 4th semester, he has to take the permission for an extension by paying the semester(s) tuition fee.

viii) Three copies of the Project Thesis certified by the supervisor shall be submitted to the Department.

ix) Project evaluation and Viva-Voce examination is conducted at the end of 4th semester by a committee consisting of Project Supervisor, senior faculty of the department, HoD and an External Examiner nominated by the Chief Controller of Examinations out of a panel of three examiners suggested by the department.

The following grades are awarded for the project work:

i. Excellent
ii. Very Good
iii Good
iv. Satisfactory
v. Unsatisfactory

The Grade “unsatisfactory” is treated as Fail. Failed Students should take supplementary examination after making required modifications, if any, in the dissertation with a minimum gap of 8 weeks by paying the required examination fee.

6. Criteria for Passing a Course and Award of Grades:

6.1 Criteria for Passing a Course:

i) A candidate shall be declared to have passed in individual theory/ drawing / design course / laboratory if he secures a minimum of 50% aggregate marks (internal & semester end examination marks put together), subject to securing a minimum of 40% marks in the semester end examination.

ii) The candidate shall be declared to have passed in seminar / comprehensive viva-voce if he secures 50% marks.

iii) The candidate shall be declared to have successfully completed the project work if he secures a minimum of ‘satisfactory’ grade in the project evaluation and viva-voce examination.

iv) On passing a course of a program, the student shall earn assigned credits in that course.

6.2 Method of Awarding Letter Grade and Grade Points for a Course:

A letter grade and grade points will be awarded to a student in each course based on his performance, as per the grading system given below.

Theory Course (%)	Laboratory (%)	Grade Points	Letter Grade
³ 90	³ 90	10	S
³ 80 & < 90	³ 80 & < 90	9	A
³ 70 & < 80	³ 70 & < 80	8	B
³ 60 & < 70	³ 60 & < 70	7	C
³ 50 & < 60	³ 50 & < 60	6	D
< 50	< 50	0	F (Fail)

S : Outstanding **A** : Excellent **B** : Very Good
C : Good **D** : Fair

6.3 Calculation of Semester Grade Point Average (SGPA)* for semester:

The performance of each student at the end of the each semester is indicated in terms of SGPA. The SGPA is calculated as given below:

SGPA = $\frac{\sum(CR \times GP)}{\sum CR}$ for each semester.

where CR = Credits of a course
GP = Grade Points awarded for a course

* SGPA is calculated for a candidate who passed all the courses in that semester.

6.4 Eligibility for Award of M.Tech Degree:

A student will be declared eligible for the award of the M.Tech Degree if he fulfills the following academic regulations.

(a) Pursued a course of study for not less than two academic years and not more than four academic years.

(b) Registered for **80** credits and secured all **80** credits.

(c) Students, who fail to complete their Two years Course of study within Four years or fail to acquire the **80** Credits for the award of the degree within four academic years from the year of their admission shall forfeit their seat in M.Tech course and their admission shall stand cancelled.

6.5 Calculation of Cumulative Grade Point Average (CGPA)* for Entire Program:

The CGPA is calculated as given below:

CGPA = $\frac{\sum(CR \times GP)}{\sum CR}$ for entire program.

where CR = Credits of a course
GP = Grade points awarded for a course

* CGPA is calculated for a candidate who passed all the prescribed courses excluding project work.

6.6 Award of Division:

After satisfying the requirements prescribed for the completion of the program, the student shall be eligible for the award of M.Tech Degree and shall be placed in one of the following grades:

CGPA	Class	Letter Grade	Description
³ 7.5	First Class with Distinction	A	Excellent
³ 6.5 & < 7.5	First Class	B	Good
³ 6.0 & < 6.5	Second Class	C	Fair

7. Supplementary Examinations :

i) Supplementary examinations will be conducted once in a year along with regular examinations.

ii) Semester end supplementary examinations shall be conducted till next regulation comes into force for that semester after the conduct of the last set of regular examinations under the present regulation.

iii) Thereafter supplementary examinations will be conducted in the equivalent courses as decided by the Board of Studies concerned.

8. Readmission Criteria :

A candidate, who is detained in a semester due to lack of attendance has to obtain written permission from the Principal for readmission into the same semester after duly fulfilling the required norms stipulated by the college and by paying the required tuition fee and special fee in addition to paying an administrative fee of Rs. 1,000/-.

9. Break in Study :

Student, who discontinues the studies for what-so-ever reason, can get readmission into appropriate semester of M.Tech program only with the prior permission of the Principal of the College, provided such candidate shall follow the transitory regulations applicable to the batch he joins. An administrative fee of Rs.2,000/- per each year of break in study, in addition to the prescribed tuition and special fees should be paid by the candidate to condone his break in study.

10. Transitory Regulations:

A candidate, who is detained or discontinued in a semester, on readmission shall be required to do all the courses in the curriculum prescribed for the batch of students in which the student joins subsequently. However, exemption will be given to those candidates who have already passed such courses in the earlier semester(s) he was originally admitted into and he will be offered

substitute subjects in place of them as decided by the Board of Studies. However, the decision of the Board of Studies will be final.

10.1 A student who is following JNTUK curriculum and detained due to shortage of attendance at the end of the first semester of first year shall join the autonomous batch of first year first semester. Such students shall study all the courses prescribed for the batch in which the student joins and considered on par with regular candidates of Autonomous stream and will be governed by the autonomous regulations.

10.2 A student who is following JNTUK curriculum, detained due to shortage of attendance at the end of the second semester of first year shall join with the autonomous batch in the second semester. Such candidates shall be required to pass in all the courses in the program prescribed by the Board of Studies concerned for that batch of students from that semester onwards to be eligible for the award of degree. However, exemption will be given in the courses of the semester(s) of the batch which he had passed earlier and substitute subjects are offered in place of them as decided by the Board of Studies. The student has to clear all his backlog subjects of first semester by appearing for the supplementary examinations conducted by JNTUK for the award of degree. The total number of credits to be secured for the award of the degree will be sum of the credits of first semester under JNTUK regulations and the credits prescribed in second semester in which a candidate seeks readmission and subsequent semesters under the autonomous stream. The class will be awarded based on the academic performance of a student in the autonomous pattern.

11. Withholding of Results

If the student has not paid the dues, if any, to the College or if any case of indiscipline is pending against him, his examinations results and degree will be withheld.

12. Malpractices :

i) The Principal shall refer the cases of malpractices in internal assessment tests and semester end examinations to a malpractice enquiry committee constituted by him for the purpose. Such committee shall follow the approved levels of punishment. The Principal shall take necessary action against the erring students based on the recommendations of the committee.

ii) Any action by the candidate trying to get undue advantage in the performance or trying to help another, or derive the same through unfair means is punishable according to the provisions contained hereunder.

DISCIPLINARY ACTION FOR MALPRACTICES/IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractices / Improper conduct	Punishment
If the candidate		
1.a	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers, cameras, bluetooth devices etc. or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination.)	Expulsion from the examination hall and cancellation of the performance in that subject only.
b	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through Cell phones with any candidates or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that semester. The hall ticket of the candidate shall be cancelled.

3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for the examinations of the remaining subjects of that semester. The candidate is also debarred for two consecutive semesters from class work and all university examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the impostor is an outsider, he will be handed over to the police and a case is registered against him.
4.	Smuggles the Answer book or takes out or arranges to send out the question paper during the examination or answer book during or after the examination.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that semester. The candidate is also debarred for two consecutive semesters from class work and all university examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.

5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of performance in that subject.
6.	Refuses to obey the orders of the Chief Superintendent / Assistant Chief Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in or around the examination hall or organises a walkout or instigates others to walkout or threatens the officer-in-charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the Officer-in-charge or any person on duty in or outside the examination hall of any of his relations or indulges in any other act of misconduct or mischief which results in damage to or destruction of property in the examination hall or any part of the college campus or engages in any other act which in the opinion of the Officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.
7.	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that semester. The candidate is also debarred for two consecutive semesters from class work and all university examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.

8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that semester. The candidate is also debarred and forfeits the seat.
9	If student of the college who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clauses 6 to 8.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that semester. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the college will be handed over to the police and a police case is registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester examinations.

12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be referred to the Chief Superintendent of Examinations for future action towards suitable punishment.

iii) The involvement of the staff, who are in charge of conducting examinations, valuing examination papers and preparing / keeping records of documents related to the examinations in such acts (inclusive of providing incorrect or misleading information) that infringe upon the course of natural justice to one and all concerned at the examination shall be viewed seriously and appropriate disciplinary action will be taken after thorough enquiry.

13. Other Matters

i) Physically challenged candidates who have availed additional examination time and a scribe during their BE / B.Tech or equivalent examinations will be given similar concessions on production of relevant proof/ documents. Students who are suffering from contagious diseases are not allowed to appear either for internal or semester end examinations.

ii) The students who participated in coaching / tournaments held at State / National / International levels through University / Indian Olympic Association during semester end external examination period will be promoted to subsequent semesters as per the guidelines of University Grants Commission Letter No. F.1-5/88 (SPE/PES), dated 18-08-1994.

iii) The Principal shall deal in an appropriate manner with any academic problem which is not covered under these rules and regulations, in consultation with the Heads of the Departments and subsequently such actions shall be placed before the Academic Council for ratification. Any emergency modification of regulation, approved in the meetings of the Heads of the Departments shall be reported to the Academic Council for ratification.

14. General

i) The Academic Council may, from time to time, revise, amend or change the regulations, schemes of examination and /or syllabi.

ii) The academic regulations should be read as a whole for the purpose of any interpretation.

iii) In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Chairman of the Academic Council is final.

iv) Wherever the word he, him or his occurs, it will also include she, her and hers.

COURSE STRUCTURE

&

SYLLABUS

M.Tech - Control Systems

COURSE STRUCTURE

I Semester

Sl. No.	Name of the Course / Laboratory	No.of Periods per week		No.of Credits
		L	P	
1	ARM Architecture and Programming	4	-	3
2	Advanced Digital Control Systems	4	-	3
3	Stochastic Estimation and Control	4	-	3
4	Advanced Control Theory	4	-	3
5	Elective - I	4	-	3
6	Elective - II	4	-	3
7	Control Systems Simulation Lab	-	6	3
	Total	**24**	**6**	**21**

II Semester

Sl. No.	Name of the Course / Laboratory	No.of Periods per week		No.of Credits
		L	P	
1	Computer Aided Design of Control Systems	4	-	3
2	Non-Linear Systems Analysis	4	-	3
3	Advanced Digital Signal Processing	4	-	3
4	Optimal Control Theory	4	-	3
5	Elective - III	4	-	3
6	Elective - IV	4	-	3
7	Advanced Control Systems Lab	-	6	3
	Total	**24**	**6**	**21**

III Semester

Sl. No.	Name of the Course / Laboratory	No.of Credits
1	Seminar	2
2	Comprehensive Viva-Voce	2
3	Dissertation (Initiated in third semester)	-
	Total	**4**

IV Semester

Sl. No.	Name of the Course / Laboratory	No.of Credits
1	Dissertation (Carried out in third & fourth semesters)	34
	Total	**34**

Electives:

I Semester	II Semester
Elective - I	**Elective - III**
Commputer Controlled Systems	Renewable Energy Sources
Engineering Optimization	AI Techniques
Process Control	Embedded Real-Time Operating Systems
Elective - II	**Elective - IV**
Power System Dynamics and Stability	Custom Power Devices
Special Machines and Control	Adaptive Control Systems
Large Scale Systems Modeling	Programmable Logic Controller

SYLLABUS

ARM ARCHITECTURE AND PROGRAMMING

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Pre - requisite:

Basic knowledge on Microcontroller 8051, Programming (preferably C), Computer Architecture and Computer logic design.

Course Objectives:

- To introduce the basic concepts of ARM architecture and processor families.
- To familiarize the various concepts of Registers, Instruction sets, Interrupts and vector tables.
- To impart the ARM programming skills.

Learning Outcomes:

Students will be able to

- understand the architecture of the ARM microcontrollers and ARM Processor Families.
- apply the concepts of Registers, Thumb Instruction sets, Memory organization and Interrupts.
- develop a real time application using ARM.

UNIT - I: ARM Architecture

ARM Design Philosophy, Registers, Program Status Register, Instruction Pipelines, Interrupts and Vector Table, Cache Architecture, Polices, Flushing and Caches, MMU, Page Tables, Translation, Access Permissions, Context Switch.[Text book 1& 2]

UNIT - II: ARM Programming Model – I

Instruction Set: Data Processing Instructions, Addressing Modes, Branch, Load, Store Instructions, PSR Instructions, Conditional Instructions. [Text book1]

UNIT - III: ARM Programming Model – II

Thumb Instruction Set: Register Usage, Other Branch Instructions, Data Processing Instructions, Single and Multi-Register Load-Store Instructions, Stack, Software Interrupt Instructions [Text book1]

UNIT - IV: ARM Programming

C Programs using Function Calls, Pointers, Structures, Integer and Floating Point Arithmetic, Assembly Code using Instruction Scheduling, Register Allocation, Conditional Execution and Loops. [Text book 1]

UNIT - V: **Embedded ARM Applications**

ARM Processor Families, VLSI Ruby II Advanced Communication Processor, ISDN Subscriber Processor, One C™ VWS22100 GSM chip, Ericsson-VLSI Bluetooth Baseband Controller, ARM 7500 and ARM 7500FE. [Text book 1]

Text Books:

1. ARM Systems Developers Guide- Design & Optimizing System Software - Andrew N. Sloss, Dominic Symes, Chris Wright, 2004, Elsevier.
2. ARM System-on-Chip Architecture, Addison Wesley – 2 Edition.

References:

1. Embedded Microcomputer Systems, Real Time Interfacing – Jonathan W. Valvano – Brookes / Cole, 1999, Thomas Learning.
2. Embedded Systems - Architecture Programming and Design – Raj Kamal, 2nd ed., 2008, TMH.
3. Designing with PIC Microcontrollers- John B. Peatman, 1998, PH Inc.

ADVANCED DIGITAL CONTROL SYSTEMS

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To familiarize with the stability concepts of digital control systems using state space.
- To introduce the basic principles to formulate optimal control problem.

Learning Outcomes:

Students will be able to

- analyze signals using z-transform methods.
- identify an appropriate stability criterion for analyzing discrete time system.
- apply the concept of controllability and observability to design an appropriate digital feedback controller.
- develop digital hardware controller.

UNIT - I: Sampling and Reconstruction

Overview of modern digital control theories, z- and inverse z- transformation and properties, difference Equation – solution by recursion and z-transform, relationship between s- plane and z-plane, sampling theorem – data conversion and quantization – mathematical modeling- data reconstruction and filtering of sampled signals – zero- order – hold.

UNIT - II: Stability Analysis

Digital control systems – pulse transfer function of open loop, closed loop systems, stability tests of linear digital control systems, relationship between G(s) and G(z).

UNIT - III: State Space Analysis

State equations of discrete data systems, solution of discrete state equations, state transition matrix: Z-transform method. Relation between state equation and transfer functions, Concepts of controllability and observability.

UNIT - IV: State Feedback Controllers and Observers

Digital State observer: Design of the full order and reduced order state observer – pole placement design by state feedback, Design of Dead Beat controller – some case studies.

UNIT - V: Digitizing Analog Controllers

Digitizing analog controllers, digital hardware control, Actuators limitation.

Text Books:

1. Discrete-Time Control systems - K. Ogata, PHI/Addison-Wesley Longman Pte. Ltd., India, Delhi, 2nd edition, 1995.
2. Digital Control Systems - Kuo, Oxford University Press, 2nd edition, 1992.
3. Digital control and state variable methods – M.Gopal, Tata McGraw Hill, India, 4th edition, 1997.

Reference Books:

1. Digital control of dynamic systems – Gene F. Frankin, J.David powell, Michael workman, pearson education, 3rd edition 2000.
2. Continuous and Discrete Control Systems – Dorsay, McGraw – Hill, 1996.
3. Digital control Systems – C.H.Houpis and G.B.Lamount, McGraw Hill, 1985.
4. Digital control systems design – Ms. Santina, A.R. Stuberud & G.H. Hostetter, oxford Univ. Press, 2nd edition.

STOCHASTIC ESTIMATION AND CONTROL

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To introduce the system models for continuous and discrete linear systems.
- To familiarize with the smooth estimate techniques for optimal estimation of continuous and discrete linear systems.

Learning Outcomes:

Students will be able to

- apply the knowledge of probability theory to stochastic control problems
- develop Kalman filter for process measurements.
- select and Design suitable observer for continuous and discrete time systems.
- design stochastic regulator for discrete time systems.

UNIT - I: Introduction

Elements of the theory of stochastic processes, Gauss-Markov sequence model, Gauss- Markov process model.

UNIT - II: Optimal Estimation For Discrete Linear Systems

Optimal estimation for discrete linear systems, optimal prediction of discrete linear systems, optimal filtering for discrete linear systems, optimal filtering in the presence of time-correlated disturbance and measurements.

UNIT - III: Optimal Smoothing For Discrete Linear Systems

Classification of smoothed estimates, single and double stage optimal smoothing, optimal fixed-interval smoothing, optimal fixed-point smoothing, optimal fixed-lag smoothing

UNIT - IV: Stochastic Optimal Control For Discrete Linear Systems

Optimal control for discrete linear systems: Problem formulation, Deterministic problem, stochastic problem

UNIT - V: Optimal Estimation For Continuous Linear Systems

Optimal estimation for continuous linear systems: Problem formulation, equivalent Discrete time problem,Optimal filtering and prediction, optimal fixed-interval smoothing, optimal fixed-point smoothing, optimal fixed-lag smoothing.

Text Books:

1. Stochastic Optimal Linear Estimation and Control, J.S.Meditch, McGraw Hill Book Company, 1969.
2. John B.Thomas, Introduction to applied probability & random processes, John Wiley,1971

Reference Books:

1. Guanroang Chen , Goong Cheu , Shih – Hsun Hsu, Linear Stochastic Control Systems, CRC Press 1995.
2. Athanasior Papoulis, Probability, Random variables and Stochastic Processes, MCG rawhill, 1984.

ADVANCED CONTROL THEORY

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To understand the concept of stability, controllability and observability of LTI systems.
- To familiarize with the design of state feedback controllers and observers for a given system.

Learning Outcomes:

Students will be able to

- apply the knowledge of matrix algebra to analyze the state space models.
- develop various state space canonical models for the physical systems.
- design controllers and observers for a given physical system.
- design an appropriate state regulator for a given system.

UNIT - I: Introduction to State Space

Introductory matrix algebra and linear vector space. State space representation of systems. Linearization of a non - linear System. Solution of state equations. Evaluation of State Transition Matrix (STM) - Simulation of state equation using MATLAB/ SIMULINK program.

UNIT - II: State Space Analysis

Similarity transformation and invariance of system properties due to similarity transformations. Minimal realization of SISO, SIMO, MISO transfer functions. Discretization of a continuous time state space model. Conversion of state space model to transfer function model using Fadeeva algorithm.

UNIT - III: Design of State Variable Feedback Systems

Fundamental theorem of feedback control - Controllability and Controllable canonical form - Pole assignment by state feedback using Ackermann's formula – Eigen structure assignment problem.

UNIT - IV: State Estimation

Linear Quadratic Regulator (LQR) problem and solution of algebraic Riccati equation using eigenvalue and eigen vector methods, iterative method. Controller design using output feedback,Observability and observable canonical form - Design of full order observer using Ackermann's formula - Bass Gura algorithm.

UNIT - V: Lyapunov Stability

Duality between controllability and observability - Full order Observer based controller design. Reduced order observer design,Internal stability of a system. Stability in the sense of Lyapunov, asymptotic stability of linear time invariant continuous and discrete time systems. Solution of Lyapunov type equation.

Text Books:

1. K. Ogata, Modern Control Engineering, Prentice Hall, India 1997
2. T. Kailath, T., Linear Systems, Perntice Hall, Englewood Cliffs, NJ, 1980.
3. N. K. Sinha , Control Systems, New Age International, 3rd edition, 2005.

Reference Books:

1. Panos J Antsaklis, and Anthony N. Michel, Linear Systems, New - age international (P) LTD Publishers, 2009.
2. John J D'Azzo and C. H. Houpis , "Linear Control System Analysis and Design Conventional and Modern", McGraw - Hill Book Company, 1988.
3. B.N. Dutta, Numerical Methods for linear Control Systems - , Elsevier Publication, 2007.
4. C.T.Chen Linear System Theory and Design - PHI, India.
5. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, 11th Edition, Pearson Edu,India, 2009.

Elective - I

COMPUTER CONTROLLED SYSTEMS

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To introduce fundamental concepts of multi variable control and large scale systems.
- To understand the concept of SCADA & distributed control systems.

Learning Outcomes:

Students will be able to

- develop models to Multi variable control systems.
- design optimal controller using H^2 / $H\alpha$ Theory.
- differentiate various communication protocols to real time systems.
- develop SCADA Architecture for a specific application.
- select a suitable control for real time memory management System.

UNIT - I: Multivariable Controls

Multivariable control- Basic expressions for MIMO systems- Singular values- Stability norms- Calculation of system norms- Robustness- Robust stability.

UNIT - II: H^2 / H Theory

H^2 / H Theory- Solution for design using H^2 / $H\alpha$ - Case studies. Interaction and decoupling- Relative gain analysis- Effects of interaction- Response to disturbances- Decoupling- Introduction to batch process control.

UNIT - III: Large Scale Control Systems

SCADA: Introduction, SCADA Architecture, Different Communication Protocols, Common System Components, Supervision and Control, HMI, RTU and Supervisory Stations, Trends in SCADA, Security Issues.

UNIT - IV: Distributed Control Systems (DCS)

Definition, Evolution of DCS, Generalized architecture of DCS, Local Control Unit (LCU), LCU languages,LCU - Process interfacing issues, communication facilities, high level and low level operator interfaces - displays, redundancy concept.

α

UNIT - V: Real Time Systems

Real time systems- Real time specifications and design techniques- Real time kernels- Inter task communication and synchronization- Real time memory management- Supervisory control- direct digital control- Distributed control- PC based automation.

Text Books:

1. Multivariable computer-controlled systems: a transfer function approach, by Efim Rosenwasser, Bernhard P. Lampe, Springer, 2006.
2. Distributed Control Systems, by Lukcas M P,Van Nostrand Reinhold Co., New York, 1986.
3. Real Time Systems: An Engineer.s Handbook, by Laplante P.A., Prentice Hall of India Pvt. Ltd.,New Delhi, 2002.
4. SCADA-Supervisory Control and Data Acquisition, by Stuart A. Boyer, Instrument Society of America Publications, USA, 1999.

Reference Books:

1. Process control systems: application, Design and Tuning, by Shinskey F.G., McGraw Hill International Edition, Singapore, 1988.
2. Process Control Instrumentation Technology, by Curtis D Johnson, Prentice Hall of India, New Delhi, Fourth edition, 1999.
3. Control Engineering: A Modern Approach, by Be.langer P.R., Saunders College Publishing , USA, 1995.
4. Elements of Process Control Applications, by Deshpande P B and Ash R H, ISA Press, New York, 1995.
5. Modern Control Systems, by Dorf, R.C. and Bishop R. T., Addison Wesley Longman Inc., 1999.

Elective - I

ENGINEERING OPTIMIZATION

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To emphasize various categories of existing engineering problems.
- To familiarize different optimization techniques and approaches.

Learning Out Comes:

Students will be able to

- apply the knowledge of Mathematics in analyzing an Engineering Problem.
- develop an optimization problem in standard form and assess the optimality of a solution.
- analyze multi objective and multidisciplinary optimization problems.
- construct algorithm for constrained and unconstrained nonlinear optimization problem of multiple variables.
- select an appropriate optimization technique for a system.

UNIT - I: Introduction

Standard form of linear programming problem (L.P.P), Geometry of L.P.P., Graphical solution, Formulation of design problems as mathematical programming problems, classification of optimization problems.

UNIT - II: Linear Optimization

Simplex method, Big-M method, two phase Simplex method, duality in optimization, duals of linear and quadratic programming problems.

UNIT - III: Unconstrained Optimization

Introduction to optimum design, General principles of optimization, Problem formulation & their classifications, Single variable and multivariable optimization. Techniques of unconstrained minimization- Golden section, Random, pattern and gradient search methods, Interpolation methods.

UNIT - IV: Constrained Optimization

Optimization with equality and inequality constraints, Direct methods, Indirect methods using penalty functions, Lagrange multipliers, Geometric programming.

UNIT - V: Advanced Optimization

Multi stage optimization, dynamic programming, stochastic programming, Multi objective optimization.

Text Books:

1. Rao, S. S., “Engineering Optimization: Theory and Practice”, 4th edition, Wiley, ISBN 978-0-470-18352-6.
2. Ravindran, K. M. Ragsdell, G. V. Reklaitis., “Engineering Optimization: Methods and Applications”, 2nd Edition ISBN: 978-0-471-55814-9.

Reference Books:

1. S.Kalavathi., “Operation Research”, 2nd Edition, Vikas Publications.
2. Taha, Hamdy, Operations Research, 7th edition, Macmillan Publishing Company.

Elective - I

PROCESS CONTROL

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To familiarize with different controllers for multi-variable and multi-loop systems.
- To introduce the modeling of various physical systems.

Learning Outcomes:

Students will be able to

- develop time series models of various processes.
- select a suitable controller for multi variable process dynamics.
- apply various performance indices to evaluate process control parameters.
- identify an appropriate strategy for reducing control loop interactions.
- design an appropriate feed-forward and feed-back controller, for multi-loop systems to meet specified performance requirements.

UNIT - I: Controller Modes

Controller modes: Basic control action, two position, multi position, floating control modes. Continuous controller modes: proportional, integral, derivative. Composite controller modes: P-I, P-D, P-I-D, Integral wind-up and prevention. Auto/Manual transfer, Bumpless transfer.

UNIT - II: Controller Tuning Methods

Controller tuning Methods: Evaluation criteria - ISE, ISTE, IAE, ITAE. Process reaction curve method, continuous oscillation method, damped oscillation method. Auto tuning. Closed loop response of I & II order systems, with and without valve.

UNIT - III: Multi-Loop and Multivariable Control

Feedback & feed forward control, cascade control, selective control loops, ratio control, feed forward and ratio control.
Multi-loop and multivariable control: process interactions, singular value analysis. PID design, tuning, trouble shooting, tuning of multi loop PID control systems.Decoupling control: strategies for reducing control loop interactions.

UNIT - IV: Process Modeling

Process Modeling: hierarchies. Theoretical models: transfer function, state space models, time series models. Development of empirical models from process data- chemical reactor modeling.

UNIT - V: Process Control System

Process Control System: Terms and objectives, Process characteristics: Process equation, degrees of freedom, modeling of simple systems – thermal, gas, liquid systems. Process lag, load disturbance and their effect on processes. Self-regulating processes, interacting and non- interacting processes.

Text Books:

1. Chemical Process Control - Stephanopoulos, 2nd Edition, Prentice Hall, New Delhi, 2003.
2. Process Systems Analysis and Control- Coughanowr, 2nd Edition, McGraw Hill, Singapore, 1991.
3. Process Control- Peter Harriott, Tata McGraw Hill, New Delhi, 1985.

Reference Books:

1. Principles and Practice of Automatic Process Control- Smith C.L and Corripio.A..B, 2nd Edition, John Wiley and Sons, New York, 1998.
2. Process Control Systems- Shinskey, 4th Edition, McGraw Hill, Singapore, 1996.
3. Fundamentals of Process Control Theory- Paul W.Murril, 3rd Edition, ISA press, New York, 2000.

Elective - II

POWER SYSTEM DYNAMICS AND STABILITY

I – Semester

Practical	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To introduce the concepts of Synchronous machine dynamics and modeling.
- To familiarize with various power system stability criterions.

Learning Outcomes:

Students will be able to

- develop Synchronous machine model.
- differentiate various power system stability considerations.
- analyze to enhance transient stability.
- analyze Small signal stability for Single Machine Infinite Bus (SMIB) system.
- design a Power System Stabilizer ((PSS) to enhance small signal stability.

UNIT - I: Introduction to System Dynamics

System dynamics- synchronous machine representation –classical model-load modelling concepts-modelling of excitation systems-modelling of prime movers.

UNIT - II: Power System Stability Considerations

Power system stability considerations – definitions-classification of stability-rotor angle and voltage stability state space representation of synchronous machine connected to a infinite bus

UNIT - III: Transient Stability and Improvement

Transient stability-swing equation-equal area criterion-solution of swing equation-Numerical methods-Euler method-Runge-Kutte method-critical clearing time and angle-effect of excitation system and governors,Multimachine stability – extended equal area criterion-transient energy function approach. – transient stability enhancement – high speed fault clearing – steam turbine fast valving-high speed excitation systems.

UNIT - IV: Small Signal Stability

Small signal stability – state space representation – eigen values- modal matrices-small signal stability of single machine infinite bus system – synchronous machine classical model representation-effect of field circuit dynamics-effect of excitation system.

UNIT - V: Small Signal Stability Improvement

Small signal stability of multimachine system, small signal stability enhancement-Power System Stabilizers (PSS)-Design of PSS

Text Books:

1. K.R.Padiyar “Power System Dynamic Stability and Control”. John Wile Interline Publishing, 1st edition 1996.
2. P.S. Kundur, “Power System Stability and Control” Mc.Graw –Hill, Nework, 1st edition 2000.

Reference Books:

1. G.Rogers, “Power System Oscillations”, Kluwer Academic Publishers, 2nd edition, 2000.
2. P.M.Anderson and A.A. Found. “Power System Control and Stability”,The Lowa State University Press, 1st edition 1997.
3. J.Machowski, J.W.Bialek and J.R.Bumby, “Power System Dynamic and Stability”, John Wiley and Sons Ltd. 1997.

Elective - II

SPECIAL MACHINES AND CONTROL

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To familiarize the students about the constructional details, principle of operation and working of special machines.
- To impart the knowledge about the load and machine torque characteristics

Learning Outcomes:

Students will be able to

- describe the construction, operating principle and control techniques of various motors.
- describe the difference between conventional DC motors and Permanent Magnet Brushless DC Motors.
- design different types of controllers.
- analyze the concept of current sheet in Linear Induction motor
- describe various applications of different types of motors.

UNIT - I: Stepper Motors

Constructional features, Principle of operation, Modes of excitation torque production in Variable Reluctance (VR) stepping motor , Dynamic characteristics, Drive systems and circuit for open loop control, closed loop control of stepping motor.

UNIT - II: Permanent Magnet Synchronous Motors(PMSM) and Switched Reluctance Motors(SRM)

PMSM: Power electronic Controllers, Torque speed characteristics, Self control, Vector control, Current control.

SRM: Constructional features, Principle of operation. Torque equation, Characteristics, Control
Techniques, Drive Concept.

UNIT - III: Permanent Magnet Brushless DC Motors

Concept of electronic commutation, Hall sensors, Optical sensors, Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Torque and emf equation, Torque-speed characteristics,
Speed control by microcontroller.

UNIT - IV: Servomotors and AC Tachometers

Servomotors: Servomotor – Types – Constructional features – Principle of Operation – Characteristics - Control – Microprocessor based applications.

AC Tachometer: AC Tachometers Schematic diagram, Operating principle, numerical problems

UNIT - V: Linear Motors

Linear Induction Motor (LIM) Classification – Construction – Principle of operation – Concept of Current sheet –Goodness factor – DC Linear Motor (DCLM) types – Circuit equation – DCLM control-applications.

Text Books:

1. Special Electical Machines -K.Venkatratnam-University Press.
2. Generalized Theory of Electrical Machines – P.S.Bimbra-Khanna publications-5th Edition.

Reference Books:

1. Miller, T.J.E. “Brushless Permanent Magnet and Reluctance Motor Drives”, Clarendon Press, Oxford, 1989.
2. Kenjo, T, “Stepping Motors and their Microprocessor control”, Clarendon Press, Oxford, 1989.
3. Naser A and Boldea I, “Linear Electric Motors: Theory, Design and Practical Application”, Prentice Hall Inc., New Jersey,1987
4. Floyd E Saner,”Servo Motor Applications”, Pittman USA, 1993.
5. Kenjo, T and Naganori, S “Permanent Magnet and brushless DC motors”, Clarendon Press, Oxford, 1989.

Elective - II

LARGE SCALE SYSTEMS MODELING

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To introduce the concepts of large scale system modeling.
- To familiarize with various order reduction techniques.

Learning Outcomes:

Students will be able to

- identify appropriate aggregation method to analyze a system..
- apply the knowledge of Routh-Hurwitz criterion to develop various order reduction techniques.
- select an appropriate order reduction method to analyze large scale systems.
- design controllers for physical systems using order reduction techniques.

UNIT - I: Time Domain Methods for Model Order Reduction

Exact and modal Aggregation, Aggregation by continued fraction, chained aggregation, weakly coupled methods, strongly coupled methods: boundary layer correction, time scale separation, multimodeling.

UNIT - II: Descriptive Variable Approach

Descriptor variable system, solvability and conditionality, time invariance, shuffle algorithm.

UNIT - III: Frequency Domain Methods for Model Order Reduction

Moment matching, pade-approximation, routh-approximation, continued fraction method, error minimization methods, mixed methods and unstable systems: pade-modal method, pade-routh method.

UNIT - IV: Multi-Input-Multi—Output Systems Reduction

Matrix continued fraction method, modal-continued fraction method, pade-modal method, frequency response comparisons.

UNIT - V: Applications in Electrical Engineering

Introduction, power system model order reduction, model order reduction in transient electromagnetic phenomena, approximated model identification of electrical induction machine, the approximated fly wheel generator converter model.

Text Books:

1. 'Large Scale Systems Modelling and Control', Mohammad Jamshidi, , North Hollard (Series in systems science and engineering, vol.9), 1989.
2. Model Order reduction Techniques with Application in Electrical Engineering by L.Fortuna, G. Nunnari and A.Gallo,Springer verlog,1992.

Reference Books:

1. Efficient Modeling and Control of Large Scale System by Mohammad Pour Javad, Karlos M.Grigoriadis, 1986.
2. 'Large Scale Systems Modelling', Magdi S. Mohamoud and Madan G. Singh, Pergamon Press (International series on Systems and Control), 1981.

CONTROL SYSTEMS SIMULATION LAB

I – Semester

Practical	: 6	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To enable the students gain sufficient knowledge on the programming and simulation of Control Systems problems.
- To develop an understanding of the response of second order systems to inputs like pulse, step and sinusoidal signals and the stability of the given systems by plotting Root Locus, Bode plots and Nyquist plots using simulation.

Learning Outcomes:

Student should be able to

- acquire skills of using computer packages like MATLAB coding and SIMULINK in modeling, design and simulation of Electrical Machines, Control Systems, Power Electronics and power systems studies.
- prepare laboratory reports that clearly communicate experimental information in a logical and scientific manner.
- analyze the response for the given system and also can implement fuzzy controller to get desired requirements.
- design a PID controller to improve the stability of the given system.
- understand the transient behavior of the given system.

List of Experiments

The following experiments may be implemented in MATLAB/SIMULINK environment.

1. Preliminary Transformations:
   a. Transfer function to State space models vice- versa.
   b. Conversion of Continuous to Discrete time systems.
   c. Verification of controllability and observability of a given system.
   d. State Space to pole/zero and transfer function to pole/zero, vice- versa.
   e. Transfer function to canonical forms.
2. Stability analysis of a given system using:
   a. Root Locus.
   b. Bode plot.
   c. Nyquist plot.
   d. Lyapunov stability

3. Design Lead compensators using frequency domain analysis.
4. Design Lag compensators using frequency domain analysis.
5. ……
   a. Design of State feedback controllers.
   b. Solving Ricatti equation.
6. Implementation of Full order and minimum order Observer.
7. Construction of Simulink model for single area and two area Power system.
8. Implementation of PID controller and its effects on mass-spring-damper system.
   In addition to the above eight simulation experiments, at least any two of the simulation experiments from the following list are required to be conducted:
9. DC motor speed control system modeling and controller design using root locus method.
10. Cruise control systems modeling controller design using frequency domain method.
11. Inverted pendulum modeling and controller design using feedback control.
12. Suspension system modeling and control design in SIMULINK.

Text Books:

1. MAT LAB; an introduction with application by Amos Gilat, Wiley Student Edition.
2. MAT LAB & SIMULINK for engineers by Agam Kumar,Tyagi.
3. Getting Stated with MAT LAB by Rudraprathap, PHI, 2009.
4. Modeling and Simulation using MAT LAB SIMULINK by Dr.Shailendra Jain.

Reference Books:

1. Programming in MAT LAB for engineering by Stephen J Chapman, Cengage Learning.
2. MAT LAB for Engineering explained by Gusfasson, Fredrik, Bergmam, Niclar.

COMPUTER AIDED DESIGN OF CONTROL SYSTEMS

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To familiarize the students in finding stability of control systems using inverse Nyquist diagram.
- To understand the design of compensators using Nyquist and Inverse Nyquist diagram.
- To expose students on MATLAB software and to develop simulation models for the design of feedback controllers.

Learning Outcomes:

Students will be able to

- select an appropriate technique to reduce higher order system to lower order.
- develop various state space models.
- apply the concepts of controllability and observability to provide valid conclusions on the performance of a given system.
- describe and determine the stability of systems using inverse Nyquist diagram.
- design various compensators using Nyquist and inverse Nyquist diagram.
- develop modules for various feedback controllers using MATLAB software.

UNIT - I: Introduction

Introduction and mathematical back ground, system models, generation of system matrices- least order, decoupling zeros, mode of the system transformation – mcmillian form – reduction to least order.

UNIT - II: Controllability and Observability

Concepts of controllability and observability, controllability and observability – decomposition of state space and duality.System specification, stability – decoupling zeros, nyquist diagram. Inverse nyquist diagram.

UNIT - III: Design Of Compensators

Design of phase lead compensators from inverse Nyquist diagram – design of phase lag compensators from nyquist diagram.

UNIT - IV: Design Criteria

Design using root loci method of design, comparison with inverse nyquist diagram techniques – sensitivity design criteria, step response – frequency response – pole location – selection of criteria. Irrational transfer functions, non minimum phase response, the circle criteria – connection with the describing function.

UNIT - V: Design Of Controllers Using Matlab

Introduction of control system tool box, time and frequency domain analysis of control systems using MATLAB, stability analysis using MATLAB, controllability and observability testing using MATLAB, design of state feedback controllers.

Text Books:

1. Computer Aided Design of Control System – By Resenbrock,Academic Press, Inc. Orlando, FL, USA,1974.
2. Linear Multi Variable Control Theory by Y.S. Apte, McGraw-Hill Inc.,US - 1984

Reference Books:

1. MATLAB - control system tool box - Mathworks, USA
2. Simulation Tools for Electrical Engineering – by N. Yadaiah and G. Tulasi Ram Das, Pearson Education.

NON - LINEAR SYSTEMS ANALYSIS

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To introduce students to nonlinear dynamical systems and phenomena with examples drawn from electrical and mechanical systems.
- To familiarize students with techniques for linearization and control of nonlinear systems.
- To develop an understanding on the notion of stability, and familiarity with techniques for testing for stability.

Learning Outcomes:

Students will be able to

- gain the knowledge of nature of nonlinearities found in control systems and perform a qualitative analysis of behavior of nonlinear systems.
- analyze nonlinear systems using describing function and phase plane techniques.
- test nonlinear systems for stability using Lyapunov techniques, and stabilize nonlinear systems using feedback.
- understand the criterion, lemma and methods to analyze the stability of nonlinear systems.
- apply the knowledge of Mathematics and Physical Science to design a nonlinear controller using feedback linearization or sliding mode control.
- identify and model some realistic and challenging examples of nonlinear control Systems.

UNIT - I: Describing Function Analysis

Linear versus nonlinear systems - Describing function analysis: Fundamentals, common nonlinearities (saturation, dead - zone, on - off non - linearity, backlash, hysteresis) and their describing functions. Describing function analysis of nonlinear systems. Reliability of describing method analysis.

UNIT - II: Phase Plane Analysis

Phase plane analysis: Phase portraits, Singular points characterization. Analysis of non – linear systems using phase plane technique. Existence of limit cycles. Linearization: Exact linearization, input - state linearization, input -output linearization.

UNIT - III: Lyapunov Stability Criterion

Concept of stability, stability in the sense of Lyapunov and absolute stability. Zero - input and
BIBO stability. Second (or direct) method of Lyapunov stability theory for continuous and discrete time systems, Aizerman's and Kalman's conjecture. Construction of Lyapunov function - Methods of Aizerman, Zubov, Variable gradient method. Lure problem.

UNIT - IV: Popov's Stability Criterion

Popov's stability criterion, Generalized circle criterion, Kalman - Yakubovich - Popov Lemma.Popov's hyperstability theorem.

UNIT - V: Sliding Control

Concept of variable - structure controller and sliding control, reaching condition and reaching
mode, implementation of switching control laws. Reduction of chattering in sliding and steady state mode. Some design examples of nonlinear systems such as the ball and beam, flight control, magnetic levitation and robotic manipulator etc.

Text Books:

1. J. E. Slotine and Weiping LI, Applied Nonlinear Control, Prentice Hall.
2. Hassan K. Khalil, Nonlinear Systems, Prentice Hall, 1996.

Reference Books:

1. Sankar Sastry, Nonlinear Systems Analysis, Stability and Control.
2. M.Vidyasagar, Nonlinear Systems Analysis, Prentice - Hall International editions,1993.

ADVANCED DIGITAL SIGNAL PROCESSING

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To explore the concepts and applications of multi-rate signal processing.
- To learn concepts of signal processing in power spectrum estimation and variable filters.

Learning Outcomes:

Students will be able to

- design and implement multi-rate systems.
- oerform forward and backward predictions, noise cancellation using different techniques.
- design LMS and RLS adaptive filters.
- understand different spectral estimation techniques and linear prediction.

UNIT - I: Multirate Signal Processing and Applications

Introduction- Up sampler – Down sampler - Decimation – interpolation – Sampling rate conversion – Multistage sampling rate conversion - poly-phase structures for decimator and interpolator – Filter bank implementation –Two-channel filter banks-QMF filter banks

UNIT - II: Linear Estimation and Prediction

Linear prediction- forward and backward predictions, Solutions of the Normal equations- Levinson- Durbin algorithms. Least mean squared error criterion - Wiener filter for filtering and prediction, FIR and IIR Wiener filters.

UNIT - III: Adaptive Filters

Applications of Adaptive filters, Adaptive Direct-Form FIR filters using LMS and RLS algorithms, Adaptive Lattice-Ladder Filters

UNIT - IV: Power Spectral Estimation

Estimation of spectra from finite duration of a signal –The Periodogram-Use of DFT in Power spectral Estimation –Non-Parametric methods for Power spectrum Estimation – Bartlett, Welch and Blackman–Tukey methods –Comparison of performance of Non – Parametric power spectrum.

UNIT - V: Parametric Power Spectrum

Estimation methods –Parametric Methods - Relationship between auto correlation and model parameters, AR, MA, ARMA models for power spectral estimation, Yule-Walker and Burg methods for AR model parameters.

Text Books:

1. G. John Proakis and G. Dimitris Manolakis, Digital Signal Processing, Pearson Education, 4th edition.

References:

1. H. Monson Hayes, Statistical Digital Signal Processing and Modeling, John Wiley and Sons, Inc.2008.
2. G.John Proakis, Algorithms for Statistical Signal Processing, Pearson Education, 2002.
3. G.Dimitris and G.Manolakis, Statistical and Adaptive Signal Processing, Mc Graw Hill, 2002.
4. Sophoncles J. Orfanidis, Optimum Signal Processing, McGraw Hill, 2007
5. P. P. Vaidyanathan , Multirate Systems and Filter Banks, Pearson Education, 2008.

OPTIMAL CONTROL THEORY

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To provide physical motivation for the selection of optimal control signal to satisfy some performance measure.
- To familiarize the concepts of variational approach for the solution of optimal control problem.

Learning Outcomes:

Students will be able to

- apply the knowledge of variational approach for the solution of optimal control problem.
- select an appropriate method for the solution of optimal control problem of continuous time systems.
- apply multistage decision approach for the solution of discrete time optimal control problem.
- identify appropriate performance indices for specific application.

UNIT - I: Overview Of Optimization Techniques

An overview of optimization problem - concepts and terms related to optimization - constrained and unconstrained problems and their solutions using different techniques.

UNIT - II: Formulation Of The Optimal Control Problem

The characteristics of the plant, the requirements made upon the plant, minimum –time problem, minimum-energy problem, minimum-fuel problem, state regulator problem, output regulator problem, tracking problem, the nature of information about the plant supplied to the controller.

UNIT - III: The Calculus Of Variations

Fundamental concepts, functional of a single function, functional involving several independent functions, piecewise-smooth extremals, constrained extrema.

UNIT - IV: The Variational Approach To Optimal Control Problems

Necessary conditions for optimal control, linear regulator problems, pontryagin's minimum principle and state inequality constraints, singular intervals in optimal control problems.

UNIT - V: Dynamic Programming

The optimal control law, principle of optimality, applications of the principle of optimality to decision-making, dynamic programming applied to routing problem, interpolation, recurrence relation of dynamic programming, discrete linear regulator problem, Hamilton-Jacobi-Bellman equation, continuous linear regulator problem..

Text Books:

1. Jasbir S. Arora, Introduction to optimum design, Elesevier, 2005.
2. A Ravindran, K.M. Ragsdell, and G.V. Reklaitis, Engineering optimization : Methods and applications, Wiley India Edition.
3. Donald E.Kirk, Optimal Control Theory an Introduction, Prentice - Hall Network series - First edition,1970.

Reference Books:

1. D.S. Naidu, Optimal control systems, CRC Press, First edition, 2002.
2. Arturo Locatelli, Optimal control: An Introduction, Birkhauser Verlag, 2001.
3. S.H.Zak, Systems and Controll, Indian Edition , Oxford University, 2003.
4. Niclas Anreasson, Anton Evgrafov and Michael Patriksson, An introduction to continuous optimization, Overseas Press (India) Pvt. Ltd.

Elective - III

EMBEDDED REAL-TIME OPERATING SYSTEMS

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To impart the knowledge of embedded programming concepts.
- To familiarize with the real time operating system tools and their applications.

Learning Outcomes:

Students will be able to

- apply the concepts of Embedded Programming for real time applications.
- understand the techniques of testing and debugging of firmware.
- develop the Networking applications using RTOS.

UNIT - I: Programming concepts and Embedded Programming in C and C^{++}

Software programming in assembly language(ALP) and high level language 'C', 'C' program elements, header, source files, processor directives, macros and functions, data types, data structures, modifiers, statements, loops, pointers, queues, stacks, lists and order lists and embedded programming in C^{++}.

UNIT - II: Software Engineering Practices in the Embedded Software Development Process

Software algorithm complexity, software development process life cycle and its models, software analysis, design, implementation, testing, validation and debugging. Multiple processes in an application, problem of sharing data by multiple tasks and routines, inter process communication.

UNIT - III: Real Time Operating Systems

Operating system services, I/O subsystems, network operating systems, real time and embedded system operating systems, interrupt routines, handling of interrupt source, task scheduling models, interrupt latency and response times of the tasks as performance metrics, performance metric in scheduling models for periodic, sporadic and aperiodic tasks.

UNIT - IV: Real Time Operating System Programming Tools: µC/OS-II and VxWorks

Need of a well tested and debugged real-time operating system (RTOS), use of µC/OS-II, Vxworks. Case study of coding for an automatic vending machine and automotive applications using µC/OS RTOS, Coding for sending application layer byte streams on a TCP/IP network using RTOS VxWorks.

UNIT - V: Middleware and application software

Middleware and its application, Networking Middleware driver, Application layer software, FTP Client Application, SMTP and E-mail, HTTP Client and Server and their examples.

Text Books:

1. Raj Kamal: "Embedded Systems-Architecture, Programming and Design", Tata McGraw Hill Publications, Second Edition, 2008.
2. "Computer Architecture", A Quantitative Approach, John L. Hennessy, David A.Patterson, Elsevier Publication, 3rd Edition.

References:

1. Labrosse, "Embedding system building blocks ", CMP publishers.
2. Rob Williams," Real time Systems Development", Butterworth Heinemann Publications.
3. Dr. K.V.K.K. Prasad: "Embedded/Real-Time Systems" Dream Tech Publications.

Elective - III

AI TECHNIQUES

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To familiarize with the concept of Artificial Intelligence (AI).
- To introduce the architecture, principle of operation of Artificial Neural Networks, Fuzzy Logic and Genetic Algorithms.

Learning Outcomes:

Students will be able to

- apply the learning methods to SLFFNN and MLFFNN architectures to an Engineering problem.
- differentiate the crisp and fuzzy data.
- design Fuzzy logic Controller for an Engineering application
- select an appropriate AI technique for a specific application.

UNIT - I: Introduction to Soft Computing Techniques

Introduction to various soft computing / artificial intelligent techniques and their origin. Introduction to Neural Networks: Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Essentials of Neural Networks: Neural network Architectures-knowledge representation learning process-learning tasks and their rules

UNIT - II: Single Layer Feed Forward Neural Networks (SLFFN)

Perceptron Models: Discrete, Continuous and Multi-Category, Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem, Limitations of the Perceptron Model, Applications. Multi Layer Feed Forward Neural Networks(MLFFN)Generalized delta rule, delta rule for Multi Layer Feed Forward Neural Networks, Concept of Back Propagation, Back Propagation algorithm, Advantages and Disadvantages of Back Propagation

UNIT - III: ANN Memories and Applications

ANN Paradigms, Hebbian Learning, Bidirectional Associative Memory (BAM) architecture, BAM training and Hope field networks.
Neural Network Applications: load forecasting, fault identification, process control and identification

UNIT - IV: Classical and Fuzzy Sets

Introduction to classical sets - properties, Operations and relations; Fuzzy sets, Membership, operations, properties, fuzzy relations, cardinalities, membership functions.

UNIT - V: Fuzzy Logic System Components and Applications

Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods. Fuzzy Logic Applications: Speed control of Drives, Process Control -P, PI, PD, and PID Controllers.

Text Books:

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Rai 6th impression – PHI Publication.
2. Introduction to Artificial Neural Systems - Jacek M. Zuarda, Jaico Publishing House, 6th impression, 1997.

Reference Books:

1. Neural Networks-James Freeman and Davis Skapura, Pearson Education, 2002.
2. Neural Networks-Simon Hakins, 2nd impression Pearson Education.
3. Neural Engineering by C.Eliasmith and CH.Anderson, PHI.
   Neural Networks and Fuzzy logic System by Bart kosko, PHI Publications

Elective - III

RENEWABLE ENERGY SOURCES

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To understand the concepts of solar radiation and operating principles of different types of collectors.
- To familiarize with the potential of wind energy and the principles of Bio-conversion.

Learning Outcomes:

Students will be able to

- describe the principles of solar radiation.
- analyze the performance characteristics of vertical and horizontal axis wind mills.
- identify the conversion techniques of tidal and geothermal energy.
- select a suitable direct energy conversion technique for suitable application.

UNIT - I: Principles of Solar Radiation

Solar Energy - Availability - Solar radiation data and measurement - Estimation of average solar radiation- Solar water heater types - Heat balance – Flat plate collector efficiency – Efficiency of heat removal - Thermo siphon flow calculation - Forced circulation calculation - Evacuated collectors - Basics of solar concentrators Solar Energy Applications - Solar air heaters – Solar Chimney - Crop driers - Passive solar system - Active solar systems - Water desalination - Output from solar still – Principle of solar ponds.

UNIT - II: Wind Energy Conversion System

Wind Energy Conversion System–Siting–Rotor selection–Annual energy output–Horizontal axis wind turbine(HAWT)–Vertical axis wind turbine (VAWT)–Rotor design considerations–Numberofblades–Solidity-Bladeprofile–Upwind/Downwind–Yawsystem–Tower–Brakingsystem.

Synchronous and asynchronous generators and loads–Integration of wind energy converters to electrical networks–Inverters–Control system–Requirement and strategies–Noise–Applicationsofwindenergy.

UNIT - III: Bio - Mass

Biomass energy - Bio fuel classification – Examples of thermo chemical, Pyrolysis, biochemical and agrochemical systems – Energy farming – Direct combustion for heat – Process heat and electricity – Ethanol production and use – Anaerobic digestion for biogas – Different digesters – Digester sizing – Applications of Biogas - Operation with I.C.Engine Ocean Energy - OTEC Principle - Lambert's law of absorption - Open cycle and closed cycle - heat exchanger calculations – Major problems and operational experience.

UNIT - IV: Tidal, Wave And Geothermal Energy

Tidal Power - Principles of power generation - components of power plant – Single and two basin systems – Turbines for tidal power - Estimation of energy – Maximum and minimum power ranges - tidal powerhouse. Wave Energy – Concept of energy and power from waves – Wave characteristics – period and wave velocities - Different wave energy conservation devices (Saltor duck, oscillating water column and dolphin types) – operational experience. Geothermal Energy - Classification- Fundamentals of geophysics - Dry rock and hot aquifier energy analysis - Estimation of thermal power - Extraction techniques - Prime movers.

UNIT - V: Direct Energy Conversion

Need for DEC, Carnot cycle, limitations, principles of DEC. Thermoelectric generators, seebeck, peltier and joul Thomson effects, Figure of merit, materials, applications,MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHD Engine, power generation systems, electron gas dynamic conversion, economic aspects. Fuel cells, principles, faraday's law's, thermodynamic aspects, selection of fuels and operating conditions.

Text Books:

1. Non-Conventional Energy Sources G.D. Rai New Delhi khanna publishers 5th edition 2013.

Reference Books:

1. Renewable Energy Resources John Twidell and Tony Weir ,E & F.N.Spon london routledge 3rd edition 2014.
2. Renewable Energy Resources Basic Principles and Applications G.N.Tiwari and M.K.Ghosal Harrow U.K. Alpha science international 2005.
3. Solar Energy - Principles of thermal collection and storage/ S.P. Sukhatme New Delhi TMH 3rd edition 2010.
4. Solar Energy Thermal Processes,/Duffie & Beckman Hoboken john wiley 4th edition 2013.

Elective - IV

CUSTOM POWER DEVICES

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To emphasize on various power quality problems, their origin and mitigation methods
- To familiarize with Operation of custom power devices and their applications.
- To introduce the concept of compensation by custom power devices.

Learning Outcomes:

Students will be able to

- identify various power quality problems in power system.
- analyze different types of custom power devices.
- analyze different power factor improvement methods in converters.
- apply various control methods in inverters for reactive power compensation.
- select and design a suitable custom power device for a given application.

UNIT - I: Introduction to Electric Power Quality and Custom Power Devices

Electric Power Quality, Power Electronic applications in Power Transmission Systems, Power Electronic applications in Power Distribution Systems. Power Quality terms and Definitions, Power Quality Problems. Custom Power, Classification of Custom Power Devices - Network reconfiguration type, compensating Type.

UNIT - II: Overview of Custom Power Devices

Compensation Devices for Voltage Sags and Momentary Interruptions - Backup Energy Supply Devices - Battery UPS - Super Conducting Magnetic Energy Storage systems - Flywheel - Voltage Source Converter - Multi-level converters.

UNIT - III: Reactive Power and Harmonic Compensation Devices

Reactive power and harmonic compensation devices **-** Static Var Compensator - Topologies - Direct Connected Static Var Compensation for Distribution Systems - Static Series Compensator - Static Shunt Compensator (DSTATCOM) - Interaction with Distribution Equipment and System - Installation Considerations.

UNIT - IV: Source Transfer Switches, Solid State Limiting and Breaking Devices

Source Transfer Switch - Static Source Transfer Switch (SSTS) - Hybrid source transfer switch - High-speed mechanical source transfer switch - Solid state current limiter - Solid state breaker.

UNIT - V: Application of Custom Power Devices In Power Systems

P-Q theory - Control of P and Q - Dynamic Voltage Restorer (DVR) - Operation and control - Interline Power Flow Controller (IPFC) - Operation and control - Unified Power Quality Conditioner (UPQC) - Operation and control.

Text Books:

1. Power Quality Enhancement Using Custom Power Devices — Power Electronics and Power Systems, Gerard Ledwich, Arindam Ghosh, Kluwer Academic Publishers, 2002, 1st edition
2. Instantaneous Power Theory and Applications to Power Conditioning By Hirofumi Akagi, Edson Hirokazu Watanabe, Mauricio Aredes, Published by jhon wiley & sons, 2007, 1st edition

Reference Books:

1. Guidebook on Custom Power Devices, Technical Report, Published by EPRI, Nov 2000.
2. Custom Power Devices - An Introduction, Arindam Ghosh and Gerard Ledwich, Springer, 2002, 1st edition
3. Roger C Dugan, et.al, “Electrical Power Systems Quality”, 3rd Edition, TMH, 2012.
4. “Power Quality in Power System and Electrical Machines” by Ewald Fuchs, Mohammad A. S. Masoum Academic Press, Elsevier, 2009. 1st edition.

Elective - IV

ADAPTIVE CONTROL SYSTEMS

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To introduce theoretical aspects of an adaptive control system.
- To familiarize with practical applications of adaptive controls.

Learning Outcomes:

Students will be able to:

- understand the necessity of Adaptive control systems.
- develop first order Model Reference Adaptive Systems.
- differentiate various parameter estimation methods.
- design gain scheduling regulators.
- select an appropriate adaptive control scheme for an application.

UNIT - I: Introduction

Definitions, History of adaptive Control, Essential aspects of adaptive control, Classification of adaptive control system: Feedback adaptive controllers, Feed forward adaptive controllers, Need of adaptive control.

UNIT - II: Model Reference Adaptive System

Different configuration of model reference adaptive systems; classification of MRAS, Mathematical description, and Equivalent representation as a nonlinear time-varying system, direct and indirect MRAS.

UNIT - III: Analysis and Design of Model Reference Adaptive Systems

Model reference control with local parametric optimization (Gradient method), MIT rule, MRAS for a first order system, MRAS based on Lyapunov stability theory, Design of a first order MRAS based on stability theory, Hyper stability approach, Monopoli's augmented error approach.

UNIT - IV: Self Tuning Regulators

Introduction: The basic idea; process models, disturbance models, General linear difference equation models, model simplification, Different approaches to self-tuning, Recursive Parameter Estimation Methods: The RLS method, extended Least squares, Recursive instrumental variable method; U-D factorization, Covariance resulting, variable data forgetting. Estimation accuracy, Direct and Indirect Self-tuning regulators, Clarke and awthrop's Self tuning Controller, Pole Placement approach to self tuning control; Connection between RAS and STR.

UNIT - V: Gain Scheduling

Introduction, The Principal, Design of Gain Scheduling Regulators, Nonlinear transformations, Applications of gain scheduling.

Text Books:

1. K. J. Astrom and B. Wittenmark, Adaptive Control, Addison Wesley Publication Company, 1989.
2. R. Isermann, K. Lashmann and D. Marko, Adaptive Control Systems, Printice-Hall International (UK) Ltd. 1992.

References Books:

1. I. B Landau, Adaptive Control - The Model Reference Approach, New York; Marcel Dekker, 1979.
2. B. Roffel, P. J. Vermeer, P. A. Chin, Simulation and Implementation of self Tuning Controllers, Prentice-Hall, Englewood cliffs, NJ, 1989.
3. K. S. Narendra and A. M. Annaswamy, Stable Adaptive Systems

Elective - IV

PROGRAMMABLE LOGIC CONTROLLER

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To introduce the basic concepts of programmable logic controllers and its applications.
- To familiarize with programming and construction of ladder diagrams.

Learning Outcomes:

Students will be able to

- understand the function of various registers and their module addressing.
- apply the knowledge of programming for construction of ladder diagrams.
- develop ladder diagrams for process control.
- develop the Analog modules for signal processing and multi bit data processing.
- design PLCs for various Industrial applications.

UNIT - I: PLC Basics

PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

UNIT - II: PLC Programming

Input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill press operation.Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams for process control: Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system.Characteristics of Registers, module addressing, holding registers, input registers, output registers.

UNIT - III: PLC Functions

PLC Functions: Timer functions and Industrial applications, counters, counter function industrial applications, Arithmetic functions, Number comparison functions, number conversion functions.

UNIT - IV: Data Handling Functions

Data handling functions: SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CLR and Sweep functions and their applications. Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two axes and three axis Robots with PLC, Matrix functions.

UNIT - V: Analog PLC Operation

Analog modules and systems, Analog signal processing, multi bit data processing, analog output application examples, PID principles, position indicator with PID control, PID modules, PID tuning, PID functions.

Text Books:

1. Programmable Logic Controllers – Principles and Applications by John W. Webb and Ronald A. Reiss, PHI, Fifth Edition.
2. Programmable Logic Controllers – Programming Method and Applications by JR. Hackworth and F.D Hackworth Jr. – Pearson, 2004.

Reference Books:

1. Programmable Logic Controllers – Principles and Applications- John W Webb and Ronald A Reis ,Prentice Hall Inc., New Jersey, Third edition , 2003.
2. Programmable Logic Controllers- Frank D Petruzella, McGraw- Hill Inc.,1998.

ADVANCED CONTROL SYSTEM LAB

II – Semester

Practical	: 6	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To enable the students gain sufficient knowledge on conducting experiments on different machines to get transfer function model.
- To expose students to testing and conduct experiment to speed control of steeper motors.

Learning Outcomes:

Students will be able to

- prepare laboratory reports that clearly communicate experimental information in a logical and scientific manner.
- analyze and Design lead-lag, lag, lead compensators.
- verify the Boolean expressions using Programmable Logic Controller.

List of the Experiments

All the 10 experiments are to be conducted:

1. To obtain the moment of inertia and then develop the transfer function of the given DC Motor for (a) Armature controlled case and (b) Field controlled case. Draw the relevant block diagrams.
2. To design a Lag-Lead compensator and to obtain the characteristics by simulation using
   MATLAB®. Verify the performance using experiments with the compensator circuit made of passive elements.
3. To conduct experiment on Inverted pendulum to get its model
4. To conduct experiment on Inverted pendulum to study closed loop performance
5. To conduct experiments on the Level Process Control Station and to study the working of a level control loop.
6. Temperature controller using PID.
7. To set up an open loop control system using Micro-processor for controlling the stepper motor

8. To design a Lead compensator and to obtain the characteristics by simulation using
   MATLAB®. Verify the performance using experiments with the compensator circuit made of passive elements.
9. Effect of P, PD, PI, PID Controller on a second order systems
10. Programmable logic controller – Study and verification of truth tables of logic gates, simple Boolean expressions and application of speed control of motor?

Reference Books:

1. Control Systems By A.Nagoor Khani, RBA Publications, 1998.
2. Control Systems by A.Ananth Kumar, PHI Learning PVT LTD, 2007.
3. Advanced Control Theory by A. A.Nagoor Khani, RBA Publications, 1999.
4. Programmable Logic Controllers – Principles and Applications- John W Webb and Ronald A Reis ,Prentice Hall Inc., New Jersey, Third edition, 2003.