

S-25 March, 2013 AC after Circulars from Circular No.153 &amp; onwards

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**DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY****CIRCULAR NO. ACAD/NP/M.E./Syllabi/189/2013**

It is hereby informed to all concerned that, on recommendations of the Faculty of Engineering and Technology, the Hon'ble Vice-Chancellor has accepted the following **"Revised Syllabi with Cumulative Grade Point Average [CGPA]"** under the Faculty of Engineering & Technology on behalf of the **Academic Council Under Section-14(7) of the Maharashtra Universities Act, 1994** as appended herewith :-

Sr. No.	Revised Syllabi
[1]	Revised Syllabus of M.E. [Computer Networking Engg.],
[2]	Revised Syllabus of M.E. [Structural Engineering],
[3]	Revised Syllabus of M.E. [Water Resources Engineering],
[4]	Revised Syllabus of M.E. [Environmental Engineering],
[5]	Revised Syllabus of M.E. [Software Engineering],
[6]	Revised Syllabus of M.E. [Computer Science],
[7]	Revised Syllabus of M.E. [Control System Engineering],
[8]	Revised Syllabus of M.E. [Heat Power],
[9]	Revised Syllabus of M.E. [Manufacturing Engineering],
[10]	Revised Syllabus of M.E. [Electronics],
[11]	Revised Syllabus of M.E. [Electronics & Telecommunication],
[12]	Revised Syllabus of M.E. [Embedded System],
[13]	Revised Syllabus of M.E. [Communication Engineering],
[14]	Revised Syllabus of M.E. [Digital Communication],
[15]	Revised Syllabus of M.E. [Biotechnology],
[16]	Revised Syllabus of M.E. [CAD/CAM],
[17]	Revised Syllabus of M.E. [Thermal],
[18]	Revised Syllabus of M.E. [Design Engineering],

This is effective from the Academic Year 2013-2014 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,  
Aurangabad-431 004.  
REF.NO. ACAD/ NP/ M.E./  
SYLLABI / 2013/14092-100  
**V.C.14(7) A-08.**  
Date:- 15-06-2013.

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*(Signature)*  
Director,  
Board of College and  
University Development.

S-25 March, 2013 AC after Circulars from Circular No.153 & onwards

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**Copy forwarded with compliments to :-**

- 1] The Principals, affiliated concerned Colleges,  
Dr. Babasaheb Ambedkar Marathwada University.
- 2] The Director, University Network & Information Centre, UNIC, with  
a request to upload the above all syllabi on University Website  
[www.bamu.net].

**Copy to :-**

- 1] The Controller of Examinations,
- 2] The Superintendent, [ Engineering Unit ],
- 3] The Programmer [Computer Unit-1] Examinations,
- 4] The Programmer [Computer Unit-2] Examinations,
- 5] The Superintendent, [ Eligibility Unit ],
- 6] The Director, [E-Suvidha Kendra], in-front of Registrar's Quarter,  
Dr. Babasaheb Ambedkar Marathwada University,
- 7] The Record Keeper,  
Dr. Babasaheb Ambedkar Marathwada University.

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**D.R. BABASAHEB AMBEDKAR  
MARATHWADA UNIVERSITY,  
AURANGABAD.**



**Revised Syllabus of  
M.E. (CONTROL SYSTEM ENGG.)**

**[ Effective from July-2013 - 2014 ]**

**Dr. Babasaheb Ambedkar Marathwada University Aurangabad.**

**Faculty of Engineering & Technology**

**Rules and Regulations for M.E. & M.Tech. -2014**

➤ **What is a credit system**

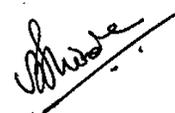
A credit system is a systematic way of describing an educational program by attaching credits to its components. The definition of credits in higher education systems may be based on different parameters; such as student workload, learning outcomes and contact hours.

➤ **Advantages of the Credit System**

- Represents a much-required shift in focus from teacher-centric to learner-centric education since the work load estimated is based on the investment of time in learning, not in teaching.
- Helps to record course work and to document learner work load realistically since all activities are taken into account-not only the time learners spend in lectures or seminars but also the time they need for individual learning and the preparation of examinations etc.
- Segments learning experience into calibrated units, which can be accumulated in order to gain an academic award.
- Helps self-paced learning. Learners may undertake as many credits as they can cope with without having to repeat all the courses in a given semester if they fail in one or more courses. Alternatively, they can choose other courses and continue their studies.

➤ **What is Grading?**

The word Grade derived from the Latin word gradus, meaning, step. Grading, in the educational context is a method of reporting the result of a learner's performance subsequent to his evaluation. It involves a set of alphabets which are clearly defined and designated and uniformly understood by all the stake holders. A properly introduced grading system not only provides for a comparison of the learner's performance but it



also indicate the quality of performance with respect to the amount of efforts put in and the amount of knowledge acquired at the end of the courses by the learners.

➤ **CURRICULUM:**

**1.1 Curriculum:**

Every program with specialization has a prescribed course structure which in general terms is known as Curriculum. It prescribes course to be studied in each semester; the relevant information containing course structure along with detail syllabus for each course of each program is updated periodically and is uploaded on the website.

**1.2 Semesters:**

The Faculty of Engineering & Technology implements a credit based curriculum and grade based evolution system for P.G. program is of four semesters. The academic courses are delivered in the first two semesters. Dissertation work is carried out by a student in the third and fourth semester. The first semester begins in the last week of July ends by the last week of November while the second semester begins in the first week of January and ends by the second week of May. Total duration for each semester is generally of 20 weeks including the period of examination, evaluation and grade declaration.

**1.3 Course Credit:**

Education is organized around the semester-based credit system of study. The prominent features of the credit system are a process of continuous evaluation of a student's performance/progress and flexibility to allow a student to progress at an optimum pace suited to his/her ability or convenience, subject to fulfilling minimum requirements for continuation.

A student's performance/progress is measured by the number of credits that he/she has earned, i.e. completed satisfactorily. Based on the course credits and grades obtained by the student, grade point average is calculated. A minimum grade point average is required to be maintained for satisfactory progress and continuation in the program. Also a minimum number of earned credits and a minimum grade point average should be acquired in order to qualify for the degree. All programmes are defined by the total credit requirement and a pattern of credit distribution over courses of different categories.

#### 1.4 Course credits assignment

Each courses, except a few special courses, has a certain number of credits assigned to it depending upon its lecture, tutorial and laboratory contact hours in a week. This weightage is also indicative of the academic expectation that includes in-class contact and self-study outside of class hours.

**Lectures and Tutorials:** One lecture or tutorial hour per week per semester is assigned one credit.

**Seminar/Contact Hours** per week per semester is assigned one credit

**Practical/Laboratory:** One laboratory hour per week per semester is assigned half credit.

**Example:** Course: XYZ Engg: 3 credits (3-1-2)

The credits indicated for this course are computed as follows:

3 hours/week lectures = 3 credits

1 hours/week tutorial = 1 credit

2 hours/week practical =  $2 \times 0.5 = 1$  credit

2 hours/week seminar =  $2 \times 0.5 = 1$  credit

Dissertation seminar/Contact Hours =  $1 \times 1 = 1$  credit

(3-1-2) 3 credit course = (3 h Lectures + 1 h Tutorial + 2 h Practical/Dissertation seminar) per week i.e. 6 Contact hours per week

#### 1.5 Earning Credits

At the end of every course, a letter grade is awarded in each course for which a student had registered. On obtaining a pass grade, the student accumulates the course credits as earned credits. A student's performance is measured by the number of credits that he/she has earned and by the weighted grade point average.

The credit system enables continuous evaluation of a student's performance, and allows the students to progress at an optimum pace suited to individual ability and convenience, subject to fulfilling minimum requirement for continuation.

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### 1.6 Evaluation System

1. Semester Grade Point Average (SGPA) =
 
$$\frac{\text{SUM (course credits in passed courses X earned grade points)}}{\text{SUM (Course credits in registered courses)}}$$
2. Cumulative Grade Point Average (CGPA) =
 
$$\frac{\text{SUM (course credits in passed courses X earned grade points) of all Semester}}{\text{SUM (Course credits in registered courses) of all Semester}}$$
3. At the end of M.E & M. Tech Program, student will be placed in any one of the divisions as detailed below.(According to AICTE Handbooks 2013-2014)
  - I<sup>st</sup> Division with distinction : CGPA  $\geq$  8.25 and above
  - I<sup>st</sup> Division : CGPA  $\geq$  6.75 and  $<$  8.25
  - II<sup>nd</sup> Division : CGPA  $\geq$  6.75 and  $<$  6.25

As per AICTE Handbook (2013-14), new gradation suggested as follows,

**Table 1**

Grade Point	Equivalent Range
6.25	55%
6.75	60%
7.25	65%
7.75	70%
8.25	75%

Conversion of CGPA to percentage marks for CGPA  $\geq$  5.0 can be obtained using equations.

$$\text{Percentage marks} = (\text{CGPA} \times 10) - 7.5$$

An example of these calculations is given below:

Typically one example for academic performance calculations of semester –I

**Table 2**

Course No. (1)	Course Credit (2)	Grade Awards (3)	Earned Credit (4)	Grade Points (5)	Points Secured (6)=(4) x (5)
Subject 1	4	B	4	6	24
Subject 2	4	C	4	5	20
Subject 3	4	O	4	10	40
Subject 4	4	A+	4	8	32
Subject 5	4	C	4	5	20
Lab-1	2	A+	2	9	18
Lab-2	1	A+	1	9	9
Seminar-I	1	A+	1	9	9
<b>Total</b>	<b>24</b>		<b>24</b>	<b>61</b>	<b>172</b>

1. Semester Grade Point Average (SGPA) =  $\frac{(172)}{(24)} = 7.16$

2. Cumulative Grade Point Average (CGPA) =  
 Cumulative points earned in all passed courses = 172 (past semester) + 172 (this sem.) = 344

Cumulative earned credits = 24 (past semesters) + 24 (this sem) = 48  
 $\frac{\sum (172 + 172)}{\sum (24 + 24)} = 7.16$

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➤ **System Evaluation Table**

**Table 3**

Grade	Grade Points	Marks Obtained (%)	Description Performance
		Regular Semester	
O	10	91-100	Outstanding
A++	09	86-90	Excellent
A+	08	76-85	Very Good
A	07	66-75	Good
B	06	56-65	Fair
C	05	46-55	Average
D	04	40-45	Poor
F	00	Below 40	Fail
EE			Incomplete
WW			Withdrawal
XX	--	--	Detained
ABSENT	--	--	Absent
PP	--	--	Passed (Audit Course)
NP	--	--	Not Passed (Audit Course)

➤ **Grade Awards:**

- i) A ten point rating scale shall be used for the evaluation of the performance of the student to provide letter grade for each course and overall grade for the Master's Programme. Grade points are based on the total number of marks obtained by him/her in all the heads of examination of the course. These grade points and their equivalent range of marks are shown separately in Table-4.

**Table 4: Ten point grades and grade description**

Sr.No.	Equivalent Percentage	Grade Points	Grade	Grade Description
1	90.00 – 100	10	O	Outstanding
2	80.00 – 89.99	9	A++	Excellent
3	70.00 – 79.99	8	A+	Exceptional
4	60.00 – 69.99	7	A	Very Good
5	55.00 – 59.99	6	B+	Good
6	50.00 – 54.99	5.5	B	Fair
7	45.00 – 49.99	5	C+	Average
8	40.01 – 44.99	4.5	C	Below Average
9	40	4.00	D	Pass
10	<40	0.00	F	Fail

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- ii) Non appearance in any examination/assessment shall be treated as the student have secured zero mark in that subject examination/assessment.
- iii) Minimum D grade (4.00 grade points) shall be the limit to clear/pass the course/subject. A student with F grade will be considered as 'failed' in the concerned course and he/she has to clear the course by reappearing in the next successive semester examinations.
- iv) Every student shall be awarded Grade points out of maximum 10 points in each subject (based on 10 Point Scale). Based on the Grade points obtained in each subject, Semester Grade Point Average (SGPA) and then Cumulative Grade Point Average (CGPA) shall be computed. Results will be announced at the end of each semester and cumulative Grade card with CGPA will be given on completion of the course.

**Proposed Coding System of M.E/M.Tech Subjects**

Six Digit Code for a subject (PG Course)

Sr. No.	Digits →	1 2 3	4	5 6
	Branch ↓	Branch code	Year	Subject
1	Electronics	MEX	PG I year – 6	Semester –I/III
2	Electronics & Communication	MEC	PG II Year - 7	1-20 Theory
3	Electronics & Telecom.	MET		21-30 Practical
4	Digital Communication	MDC		31 Dissertation-I
5	Embedded System	MES		41-49 Electives
6	Structure Engineering	MSE		Semester –II/IV
7	Environmental Engineering	MEV		51-70 Theory
8	Water Resource Engineering	MWR		71-80 Practical
9	Computer Engineering	MCE		81 Dissertation-II
10	Computer Network	MCN		91-99 Electives
11	Software Engineering	MSW		
12	Mechanical Engineering	MME		
13	Thermal Engineering	MTE		
14	CAD/CAM	MCC		
15	Manufacturing	MMF		
16	Heat Power	MHP		
17	Design Engineering	MDE		
18	Machine Design	MMD		
19	Automation	MEA		
20	Chemical Engineering	MCH		
21	Computer & IT	MCI		
22	Production Process	MMP		
23	M.Tech Computer Science	MTC		
24	M.Tech Food Processing	MTF		
25	M.Tech Mechanical	MTM		

**Note: - Kindly, Allot Same Code for same Electives/ subjects for different branches to avoid repetitions of Question papers/settings/assessments.**

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**DEGREE OF MASTER OF ENGINEERING/TECHNOLOGY**  
(Course with effective from academic year: 2013-2014)

<b>I</b>	<b>1</b>	The examination for the Degree of Master of Engineering & Technology will be held in four semesters, M.E./M.Tech. Semester-I, M.E./M.Tech. Semester-II, M.E. /M.Tech Semester-III, and M.E./M.Tech. Semester-IV in case of full time course. And for part time additional semester V & VI
<b>II</b>	<b>1</b>	<b>Rules &amp; Eligibility</b> Rule for admission to P.G. Degree course in Engineering and Technology as per rules and regulation of AICTE/DTE & Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.
<b>III</b>	<b>1</b>	<b>Evaluation method</b> Each theory course will be of 100 marks and be divided in to internal examination of 20 marks and semester examination of 80 marks (20+80=100 marks). Each practical course will be of 50/100 marks
	<b>2</b>	There shall be minimum two class tests within a semester. First based on 30% syllabus taught and second based on 30% syllabus taught. The setting of question paper and assessment will be done by the concerned teacher who has taught the syllabus. Average marks obtained out of two examinations will be considered for the preparation of final sectional marks/ grade.
	<b>3</b>	The Question papers in theory subjects shall be set by the Examiners appointed for the purpose by the University on the recommendations of the Board of studies of the concerned PG Course.
	<b>4</b>	The assessment of the Practical for any subject will be done by recognized post-graduate teacher appointed by University.
	<b>5</b>	To pass the examination a candidate must obtain a minimum CGPA of 6.25 (CGPA to the scale of 10).
	<b>6</b>	Candidate who secures $CGPA \geq 6.25$ and $CGPA < 6.75$ declared to have passed examination in second class.
	<b>7</b>	Candidate who secures $CGPA \geq 6.75$ and $CGPA < 8.25$ declared to have passed examination in first class.
	<b>8</b>	Candidate who secures $CGPA \geq 8.25$ declared to have passed examination in

		first class with distinction.
IV	1	In case candidates fails to get less than D grade in one or more heads of passing examination, he will be allowed at his option, to reappear for only those heads of passing in which he has failed or got less than D grade at subsequent examinations.
	2	The grades obtained by the candidate in any head of passing at the examination will be carried forward unless the candidates reappear for the head of passing in accordance with ref. IV (1)
	3	In case the candidate passes in all heads of passing under M.E./M.Tech. Semester-I; M.E./M.Tech. Semester-II examination and obtained a minimum CGPA of 6.25 in M.E./M.Tech Semester-I, M.E./M.Tech Semester-II taken together as required under ref. II(2) above, he will not be allowed to reappear for any head of passing under M.E. Semester-I, M.E. Semester-II in accordance with ref. III(5)
	4	A candidate will not be allowed to appear for M.E. /M.Tech Semester-III examination unless he passes in all heads of passing under M.E. /M.Tech Semester-I, M.E./M.Tech Semester-II examination and obtains a minimum CGPA of 6.25.
	5	Whenever a candidate reappears for M.E. /M.Tech Semester-III and M.E./M.Tech. Semester-IV examinations he will have to resubmit the dissertation with suitable modification and must also reappear for oral examination on it.
	6	A candidate registered for M.E./M.Tech Examination must clear his examination within five years from the date of registration.
V	<b>Attendance Requirement</b>	
	1	Each semester of the course shall be treated as a separate unit for calculation of the attendance
	2	A candidate shall be considered to have satisfied the attendance requirement if he/she has attended not less 75% of the class in each subject of all the semesters (Theory, Laboratory, Semester Practical training and Dissertation work) actually conducted up to the end of the semester.
	3	A Candidate, who does not satisfy the attendance required, mentioned as above, shall not be eligible to appear for the Examination of that semester and

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		shall be required to repeat that semester along with regular students later.
	4	The Principal of the concerned College shall display regularly, the list of such candidates who fall short of attendance, on the Notice Boards.
	5	The list of the candidates falling short of attendance shall be sent to the University at least one week prior to the commencement of theory/practical examination, whichever is earlier.
VI		The following are the syllabi in the various subjects of the examination for the Degree of Master of Engineering/Technology.

## Faculty of Engineering and Technology

## Tentative Structure for ME (CONTROL SYSTEM ENGINEERING)

Sub	Semester - I	Contact Hrs/Week				Examination Scheme (Marks)						Credit
		L	T	P	Total	CT	TH	TW	P	Total	Duration of Theory Examination	
Part – I												
1	Advance Control Theory.	3	1	-	4	20	80	-	-	100	3 Hrs.	4
2	Advance Process Control.	3	1	-	4	20	80	-	-	100	3 Hrs.	4
3	Advance Digital Processing Systems.	3	1	-	4	20	80	-	-	100	3 Hrs.	4
4	Intelligent Control Systems.	3	1	-	4	20	80	-	-	100	3 Hrs.	4
5	Elective - I	3	1	-	4	20	80	-	-	100	3 Hrs.	4
6	ACT Lab.	-	-	4	4	-	-	50	-	50	-	2
7	ADPS Lab.	-	-	2	2	-	-	-	50	50	-	1
8	Seminar.	-	-	2	2	-	-	-	50	50	-	1
<b>Total of Part – I</b>		15	5	8	28	100	400	50	100	650		24

L: Lecture hours per week

T: Tutorial Hours per week

P: Practical hours per week

CT: Class Test

TH: University Theory Examination TW: Termwork

P: Practical / Oral Examination

**Elective – I**

1. Advance Drives and Controls.
2. Digital Image Processing.

**Faculty of Engineering and Technology****Tentative Structure for ME (CONTROL SYSTEM ENGINEERING)**

Sub	Semester – II	Contact Hrs/Week				Examination Scheme (Marks)						Credit
		L	T	P	Total	CT	TH	TW	P	Total	Duration of Theory Examination	
Part – II												
1	Non-Linear Control Theory.	3	1	-	4	20	80	-	-	100	3 Hrs.	4
2	Advance Digital Control Systems.	3	1	-	4	20	80	-	-	100	3 Hrs.	4
3	System Identification and Adaptive Control.	3	1	-	4	20	80	-	-	100	3 Hrs.	4
4	Optimal Control Systems.	3	1	-	4	20	80	-	-	100	3 Hrs.	4
5	Elective - II	3	1	-	4	20	80	-	-	100	3 Hrs.	4
6	NCT Lab.	-	-	4	4	-	-	50	-	50		2
7	ADCS Lab.	-	-	2	2	-	-	-	50	50		1
6	Mini Project.	-	-	2	2	-	-	-	50	50	-	1
<b>Total of Part – II</b>		15	5	8	28	100	400	50	100	650		24

**L:** Lecture hours per week**T:** Tutorial Hours per week**P:** Practical hours per week**CT:** Class Test**TH:** University Theory Examination **TW:** Termwork**P:** Practical / Oral Examination**Elective – II**

1. Intelligent Instrumentation.
2. Robust control system.

### Faculty of Engineering and Technology

#### Tentative Structure for ME (CONTROL SYSTEM ENGINEERING)

Sub	Semester – III	Contact Hrs/Week				Examination Scheme (Marks)						Credit
		L	T	P	Total	CT	TH	TW	P	Total	Duration of Theory Examination	
Part – III												
I	Dissertation (Part - I)	-	-	12	12	-	-	-	50	50	-	12
<b>Total of Part – III</b>				12	12				50	50		12

Sub	Semester – IV	Contact Hrs/Week				Examination Scheme (Marks)						Credit
		L	T	P	Total	CT	TH	TW	P	Total	Duration of Theory Examination	
Part – IV												
I	Dissertation (Part - II)	-	-	20	20	-	-	50	200	250	-	20
<b>Total of Part – IV</b>				20	20			50	200	250		20

**L:** Lecture hours per week

**T:** Tutorial Hours per week

**P:** Practical hours per week

**CT:** Class Test

**TH:** University Theory Examination

**TW:** Termwork

**P:** Practical / Oral Examination

**Total:- SEM-I + SEM-II + SEM-III + SEM-IV**  
 = 24 + 24 + 12 + 20  
 = 80

**Total Contact Hours**  
**SEM-I + SEM-II + SEM-III + SEM-IV**  
 = 28 + 28 + 12 + 20 = 88

SEMESTER-I

**MECS101 - ADVANCE CONTROL THEORY**

Teaching Scheme:

Lecture - 03 Hrs.

Tutorial - 01 Hrs.

Examination Scheme:

Theory Paper - 80 Marks

Class Test - 20 Marks

**1. MATHEMATICAL PRELIMINARIES**

**(10 HRS)**

Linear vector spaces and linear operators, Fields, vectors and vector spaces, Linear dependence, Dimension of linear space, The notion of bases, Linear transformation and matrices, Scalar product and norms, Quadratic function and definite matrices, vector and matrix norms. Solution of linear algebraic equation: Range space, Rank, Null space and nullity of a matrix, Homogenous and nonhomogeneous equations, Eigen values and Eigenvectors and Canonical form representation of linear operators, Functions of square matrix: Caley-Hamilton theorem.

**2. STATE VARIABLE ANALYSIS OF MULTIVARIABLE CONTROL SYSTEMS**

**(10 HRS)**

The concept of state and state models, State equations for dynamic systems, State equations using phase, physical and canonical variables, Plant models of some illustrative control systems, State space representation and realization of transfer matrices, Minimal realization, Solution of state equation.

Concept of Controllability and Reachability, Observability and Constructibility, Controllable and Uncontrollable subspace, Observable and unobservable subspace, Controllability and Observability tests:Kalman's test matrix, Gilbert's test, Controllability and observability canonical forms.

**3. MULTIVARIABLE CONTROL SYSTEMS DESIGN**

**(10 HRS)**

Linear state variable feedback: The effect of state feedback on controllability and observability, Necessary and Sufficient condition for arbitrary pole placement, Ackermann's formula for pole placement, State observers: Full-order state observers and minimum order observers, study of some physical plant like inverted pendulum for analysis and design.

**4. STATE SPACE AND MATRIX-FRACTION DESCRIPTIONS OF MULTIVARIABLE SYSTEMS (10 HRS)**

State observability, controllability and Matrix-fraction description (MFD) of a transfer function, Some properties of polynomial matrices, Some basic state space realization, The Smith-Mc-Millan form of a transfer function matrix, Poles and Zeros of a transfer function matrix, State space realization from a transfer function matrix, Internal stability, The generalized Nyquist and inverse Nyquist stability criterion.

**REFERENCES:**

1. C. T. Chen, "*Linear System Theory and Design*", Holt, Rinehart and Winston, New York, 1984.
2. T. Kailath, "*Linear Systems*", Prentice-Hall, Englewood Cliffs, NJ, 1980.
3. M. Gopal, "*Modern Control System Theory*", Second Edition, New Age International (P) Limited, New Delhi, 1996.
4. W. A. Wolovich, "*Linear Multivariable Systems*", Springer-Verlag, and Berlin, 1974.
5. P. J. Antsaklis and A. N. Michel, "*Linear Systems*", McGraw-Hill International Editions, 1998.
6. K. Ogata, "*Modern Control Engineering*", Third Edition, Prentice-Hall of India, New Delhi, 1997.

**MECS102 - ADVANCED PROCESS CONTROL**

Teaching Scheme:

Lecture - 03 Hrs.

Tutorial-01 Hrs.

Examination Scheme

Theory Paper - 80 Marks

Class Test - 20 Marks

1. Introduction to performance characteristics of different transducers and systems, Dynamic analysis of measurement systems, errors in instrumentation systems.  
(2 HRS)
2. Introduction to process control, representative process control problems, classification of process control strategies, Major steps in control system developments.  
(4 HRS)
3. Introduction to Unit Operations and theoretical modeling, concept of Unit and Unit Operation, Material Balance and Energy Balance, Introduction to Evaporation, Distillation, Crystallization processes and associated Instrumentation and control, Introduction to process equipments like Continuous Stirred Tank Reactor (CSTR), Heat Exchanger, liquid storage systems and their modeling, dynamic behavior of first and second order processes, dynamic response of the processes, development of empirical models for process data.  
(14 HRS)
4. Overview of process control system design: introduction, degree of freedom for process control, selection of controlled, manipulated and measured variable, process safety and process control.  
(6 HRS)
5. Control system instrumentation, introduction, basic control modes, on-off controller, features of PID controller, PID controller design, tuning and trouble shootings, digital version of PID controller, electronic/pneumatic/hydraulic controller, optimum control settings, transducers, transmitters, transmission lines, final control elements and their calculations and selection.  
(10 HRS)
6. Feed forward and ratio control, cascade control: Introduction to Feed forward and ratio control, cascade control and their design consideration, tuning.  
(4 HRS)

**REFERENCES:**

1. E. Seborg, Thoman F. Edgar, Dyncan A. Mellichamp, "*Process Dynamics and Control*", Dale IInd Edition , Willey publication.
2. B. G. Liptak, "*Instrument Engineers Handbook*", Vol. I and II, Third Edition, Chilton and Book Company, 1990.
3. Peter Harriot , "*Process control*", Tata McGraw hill.
4. D. Ekman, Wiley, "*Automatic Process Control*", Eastern Ltd.
5. F.G. Shinsky, "*Process Control System Application, Design and Tunning*", McGraw hill.
6. M. C. Cabe, "*Unit Operation and Chemical Engineering*", McGraw hill Publication.
7. Shreve, "*Chemical Process Industries*", McGraw hill Publication.

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**MECS103 - ADVANCED DIGITAL SIGNAL PROCESSING SYSTEMS**

Teaching Scheme:

Lecture - 03Hrs.

Tutorial - 01Hrs.

Examination Scheme:

Theory Paper - 80 Marks

Class Test - 20 Marks

- 1. INTRODUCTION TO DSP CONCEPTS (8 HRS)**  
Introduction, Continuous time and discrete time signals, Transformations of independent variable, Exponential and Sinusoidal Signals, Unit impulse and unit step functions, basic properties. LTI Systems: Introduction, Convolution sum, Convolution integral, Properties of LTI systems.
- 2. DISCRETE FOURIER TRANSFORM (4 HRS)**  
Representation, properties and computation of the DFT (FFT), decimation in time and frequency.
- 3. FILTER DESIGN TECHNIQUES (6 HRS)**  
Design of IIR filters, Impulse invariance, bilinear transformation Design of FIR filters by windowing and frequency sampling.
- 4. QUANTIZATION EFFECTS (8 HRS)**  
Effect of round off noise in digital filter, zero input limit cycles in fixed point realization of IIR digital filters. Effects of finite register length in DFT computations.
- 5. WAVELET TRANSFORM (6 HRS)**  
Introduction to wavelets, wavelets and wavelet expansion systems, discrete wavelet transform, multiresolution formulation of wavelet systems, Haar Wavelet and other wavelet representations, scaling function, wavelet functions, Parseval's theorem.
- 6. MULTIRATE SIGNAL PROCESSING & FILTER BANKS (8 HRS)**  
Introduction, Decimation, Interpolation, Fractional rate conversion, Multistage Filter implementation. Interpolated FIR filter (IFIR), IFIR technique for decimation filter and interpolation filter. Analysis and Synthesis banks. Poly phase structures – Polyphase structure for decimation and interpolation filters, filter Banks.

**REFERENCES:**

1. J.G Proakis and D.G Manolakis, "*Digital Signal Processing: Principles, Algorithms and Applications*", PHI, 2004.
2. S. K. Mitra, "*Digital signal processing: A computational Approach*", TMH. Johny Johnson, Introduction to digital signal processing, PHI.
3. Oppenheim, Schafer, and Buck, "*Discrete-time Signal Processing*", Pearson Education LPE.
4. P. P. Vaidyanathan, "*Multirate Filters and Filter Banks*", PH International, Englewood Cliffs, 1993.
5. Rabiner and Schafer, "*Multirate Signal Processing*", PH International, Englewood Cliffs.
6. C. S. Burrus, R. A. Gopinath, H. Guo, "*Introduction to Wavelets and Wavelet Transform*", Prentice Hall Inc. 1998.

### **MECS104 - INTELLIGENT CONTROL SYSTEMS**

Teaching Scheme:

Lecture - 03 Hrs.

Tutorial - 01 Hrs.

Examination Scheme:

Theory Paper - 80 Marks

Class Test - 20 Marks

#### **1. INTRODUCTION AND FUNDAMENTALS OF ARTIFICIAL NEURAL NETWORKS (6 HRS)**

Biological prototype. Artificial Neuron Single Layer ANN, Multi layer ANN, training of Artificial NN. Perceptrons: Perceptron representation, perceptron learning, perceptron training algorithm.

#### **2. FUNDAMENTALS OF ERROR BACK PROPAGATION LEARNING (8 HRS)**

Introduction, Learning Rules, Multi layer Feedforward neural network, Generalized delta rule, Need of generalized delta rule; Requirements For Back propagation learning; Derivation of generalized delta rule; Flowchart for training of network using generalized delta rule; Algorithm for EBP; Difference in Delta and Generalized Delta learning rule; Learning factors; Training Errors; Data Normalization and Denormalization; Initialization of the weights; Selection of learning rate and momentum factor; Selection of proper activation function; Selection of number of hidden layers; Selection of hidden layer neurons; Generation and using the network learning curves.

#### **3. PROCESS MODELLING AND CONTROL (6 HRS)**

Introduction, Overview of process control applications, Why neural networks in control system.? Process Modelling by neural network; Direct Adaptive Control, Self Tuning Controller, Indirect Adaptive Control, Model Reference Adaptive Control, Internal Model Control, Model Predictive Control, Cascade Control.

#### **4. INTRODUCTION TO FUZZY LOGIC (8 HRS)**

Classical sets and fuzzy sets: Vagueness, Fuzzy set theory versus Probability theory, Operation and properties of classical and fuzzy sets. Classical relations and fuzzy relations: Cartesian Product, Crisp relations, Fuzzy relations, Operations on fuzzy relations, Various types of binary fuzzy relations, Fuzzy relation equations, The extension principle and its applications, Tolerance and equivalence relations, Crisp equivalence relation, Crisp tolerance relation, Fuzzy tolerance and equivalence relation, Value assignments.

**5. FUZZY KNOWLEDGE BASED CONTROLLERS (FKBC) DESIGN PARAMETERS (6 HRS)**

Introduction, Structure of a FKBC, Fuzzification and defuzzification module, Rule base, Choice of variable and contents of rules, derivation of rules, data base, choice of membership function and scaling factors, choice of fuzzification and defuzzification procedure, various methods.

**6. NEURAL NETWORKS AND FUZZY LOGIC APPLICATIONS IN CONTROL SYSTEM APPLICATIONS (6 HRS)**

Inverted pendulum, Aircraft landing, Temperature control of Heat exchanger, speed control of DC motor, concentration control in chemical reactor.

**REFERENCES:**

1. B. Yegnanarayana, "*Artificial Neural Networks*", Prentice Hall of India, Private limited, New Delhi, 1999.
2. J.M. Zurada, "*Introduction to Artificial Systems*", Singapore: Info Access and distributions, 1992.
3. D. Drainkov, H. Hellendoorn and M. Reinfrank, "*An Introduction to Fuzzy Control*", Narosa Publishing House, 1993.
4. T. J. Ross, "*Fuzzy Logic with Engineering Applications*", McGraw Hill, Inc 1995
5. Neural network, "*Fuzzy Logic and Genetic Algorithm*" by Rajshekharan

## MECS105 - EL-I ADVANCE DRIVES AND CONTROLS

Teaching Scheme:

Lecture- 03 Hrs

Tutorial – 01 Hrs

Examination Scheme:

Theory Paper - 80 Marks

Class Test - 20 Marks

### 1. DC MOTOR DRIVES

(8 HRS)

Starting, braking, transient analysis, speed control, methods of armature voltage-control, Ward Leonard drives, Transformer and uncontrolled rectifier control, multi-quadrant operation of dc separately excited motor fed from fully-controlled rectifier, rectifier control of dc series motor, control of fractional hp motors, supply harmonics, power factor and ripple in motor current, chopper-controlled dc drives, chopper control of separately excited dc motors, chopper control of dc series motor, source current harmonics in choppers, converter ratings and closed-loop control.

### 2. AC MOTOR DRIVES: INDUCTION MOTOR DRIVES

(10 HRS)

Starting, braking, transient analysis, speed control, stator voltage control, variable frequency control from voltage sources, VSI control, cycloconverter control, CSI control, current regulated VSI control, eddy current drives, rotor resistance control, variable speed constant frequency generation, static Kramer drive and dynamic d-q<sup>2</sup> model, voltage and current fed scalar control, direct and indirect vector control, sensor less vector control, direct torque and flux control, linear induction motor and its control.

**SYNCHRONOUS MOTOR DRIVES:** Operation from fixed frequency supply, variable speed drives, variable frequency control, self-controlled synchronous motor drives employing load commutated thyristor inverter and a cycloconverter.

### 3. BRUSHLESS DC MOTOR DRIVES

(4 HRS)

Brushless dc (or Trapezoidal PMAC) motor drives for servo applications, low cost brushless dc motor drives, important features and applications.

### 4. STEPPER MOTOR AND SWITCHED RELUCTANCE MOTOR DRIVES

(5 HRS)

Stepper (or Stepping) motors, types, important features, torque versus stepping (or pulsing) rate characteristics, drive circuits for stepper motors, switched (or variable) reluctance motor, operation and control requirements, converter circuits, modes of operation.

**5. SOLAR AND BATTERY POWERED DRIVES (5 HRS)**

Solar (or photovoltaic) panels, motors suitable for pump drives, solar powered pump drives, battery powered vehicles, solar powered electrical vehicles and boats.

**6. TRACTION DRIVES (8 HRS)**

Electric traction services, nature of traction load, braking, power factor and harmonics, calculations of traction drive rating and energy consumption, important features of traction drives, traction motors, semiconductor converter controlled drives, 25 kV ac traction using semiconductor convertor controlled dc motors, dc traction using semiconductor chopper controlled dc motors, dc traction employing polyphase ac motors, ac traction employing polyphase ac motors.

**TEXT BOOKS:**

1. G. K. Dubey, "*Fundamentals of Electrical Drives*", Narosa Publishing house.
2. B. K. Bose, "*Modern Power Electronics and AC drives*", Pearson Education, Asia, 2003.
3. M. H. Rashid, "*Power Electronics*", Third Edition, PHI.

**REFERENCES:**

1. V. Subrahmanyam, "*Electric Drives-Concepts and Applications*", TMH.
2. G. K. Dubey, "*Power Semiconductor controlled drives*", PH 1989.
3. R. Krishnan, "*Electric Motor Drives: Modeling, Analysis and Control*", PH, 1998.
4. P. Vas, "*Sensor less vector and direct torque control*", Oxford Press, 1998.
5. Werner Leonhard, "*Control of electrical drives*, Springer, 1995.
6. S.K.Pillai, "*Electric Drives*, University Press India, 1993.

**MECS105 - EL-II DIGITAL IMAGE PROCESSING**

Teaching Scheme:

Lecture - 03 Hrs.

Tutorial - 01 Hrs.

Examination Scheme:

Theory Paper - 80 Marks

Class Test - 20 Marks

1. **INTRODUCTION (4 HRS)**  
 Digital image representation, fundamental steps in image processing, elements of digital image processing systems, hardware for image processing system - Frame Graber, Characteristics of image digitizer, Types of digitizer, Image digitizing components, Electronic image tube cameras, solid state cameras, scanners.
2. **DIGITAL IMAGE FUNDAMENTALS (6 HRS)**  
 Elements of visual perception, a simple image model sampling and quantization some basic relationship between pixels, image geometry, Basic transformations, Perspective transformation, Camera model and calibration, stereo imaging.
3. **IMAGE TRANSFORMS (6 HRS)**  
 2-D Fourier transform, Fast Fourier transform, Other separable transforms, Walsh Transform, Hadamard Transform, Discrete Cosine Transform, wavelet Transform- Haar function, Gabor Transform, Hotelling transforms.
4. **IMAGE ENHANCEMENT (4 HRS)**  
 Enhancement by point processing, spatial filtering, enhancement in the frequency domain, Color image processing.
5. **IMAGE RESTORATION (7 HRS)**  
 Degradation model, diagonalization of circulate and block-circulate matrices, algebraic approach to restoration, inverse filtering, least mean square (wiener) filter, constrained least squared restoration, invractive restoration.
6. **IMAGE COMPRESSION (7 HRS)**  
 Redundancies, image compression models, elements of information theory, error-free compression- variable length coding, bit plane coding, lossless predictive coding, lossy compression – predictive coding, transform coding, video compression, image compression standards- JPEG, MPEG.

**7. IMAGE ANALYSIS**

**(6 HRS)**

Segmentation - detection of discontinuities, edge linking and boundary detection, thresholding, region -oriented segmentation, Representation and description: Representation schemes, descriptors, regional descriptors, pattern and pattern classes, Classifiers.

**REFERENCES:**

1. R. C. Gonzalez and R. E. Woods, "*Digital Image Processing*", Pearson Education Asia, 2002.
2. A. K. Jain, "*Fundamentals of Digital Image Processing*", Prentice Hall of India Pvt Ltd, New Delhi, India, 1989.
3. K. R. Castleman, "*Digital Image Processing*", Prentice-Hall International, 1996.

**MECS106 – ACT LAB.**

Teaching Scheme:

Practical - 4 Hrs/Week

Examination Scheme:

Termwork - 50 Marks

It shall consist of a minimum of 8 experiments based on the syllabus of Advance Control Theory.

**MECS107 – ADPS LAB.**

Teaching Scheme:

Practical - 2 Hrs/Week

Examination Scheme:

Practical - 50 Marks

It shall consist of a minimum of 8 experiments based on the syllabus of Advance Digital Processing Systems.

**MECS108 - SEMINAR**

Teaching Scheme:

Practical - 2 Hrs/Week

Examination Scheme:

Practical - 50 Marks

The Seminar will consist of a type written report covering the topic selected for the seminar. The candidate shall deliver the seminar on the topic which will be judged by two examiners and the marks will be given accordingly.

**SEMESTER-II**

**MECS201- NON-LINEAR CONTROL SYSTEM**

Teaching Scheme:

Lecture - 03Hrs.

Tutorial - 01Hrs.

Examination Scheme:

Theory Paper - 80 Marks

Class Test - 20 Marks

**1. INTRODUCTION TO NON LINEAR SYSTEM (6 HRS)**

Classification of non-linearity, types of non-linearity in physical system, jump phenomena and critical jump resonance curve, methods of analysis of non-linear systems and comparison, linearization, slope, isoclines, singular point, limit cycle.

**2. PHASE PLANE ANALYSIS (8 HRS)**

Concept of phase plane, phase trajectory, phase portraits, methods of plotting phase plane trajectories Vander Pol's equation, stability from phase portrait, time response from trajectories, isoclines method, Delta method of phase trajectory construction.

**3. FREQUENCY DOMAIN ANALYSIS (6 HRS)**

Absolute stability, circle criterion, Popov criterion Describing function, DF of typical nonlinearities stability analysis using DF method, DIDF, pole zero shifting transformation.

**4. LYAPUNOV STABILITY (8 HRS)**

Autonomous Systems: Stability of equilibrium point. Concepts of positive definite/semi definite, negative definite/ semi definite, indefinite functions, Lyapunov function Lyapunov Stability: asymptotic stability, global asymptotic stability.

**5. STABILITY CRITERION (8 HRS)**

Linear systems, linearization of nonlinear systems about equilibrium point. Lyapunov's indirect method. Stability analysis of nonlinear system using Lyapunov's theorem.

**6. NONLINEAR CONTROL DESIGN (4 HRS)**

Feedback linearization, Input Output linearization, sliding mode control.

**TEXT BOOKS:**

1. George J. Thaler, "Automatic Control System", Brown, Jaico Publications
2. Hasan A. Khalil, "Nonlinear Systems", Prentice Hall of India

**REFERENCES:**

1. Samarjit Ghosh, "*Control Systems Theory and Application*", Pearson Education
2. Nagrath and Gopal, "*Control System Engineering*", Wiley Eastern
3. A. K. MandaI, "*Introduction to Control Engineering*", New Age International Publications
4. H. Khalil, "*Nonlinear Control Systems*", PHI New Jersy.

**MECS202 - ADVANCE DIGITAL CONTROL SYSTEMS**

Teaching Scheme:

Lecture - 03 Hrs

Tutorial - 01 Hrs

Examination Scheme

Theory Paper - 80 Marks

Class Test - 20 Marks

**1. DIGITAL CONTROL (8 HRS)**

Need of digital control, Configuration of the basic digital control scheme, Principles of signal conversion, Basic discrete time signals, Time domain models for discrete time systems, Transfer function models, digital temperature control system, digital position control system, stepping motors and their control, Stability on Z-plane and jury stability criterion.

**2. DIGITAL SIMULATION AND DIGITAL REDESIGN (8 HRS)**

Introduction, Digital modeling with sample and hold devices, State variable formulation, numerical integration, Frequency domain characteristics, warping and prewarping, Digital Redesigning, Closed form solution for  $G(T)$ , Partial matching of states, Solution of the feedback matrix by series expansion, Exact solution of  $E(T)$  by series expansion, Stability consideration and constraints on the selection of weighing matrix.

**3. STATE VARIABLE ANALYSIS OF DIGITAL CONTROL SYSTEMS (6 HRS)**

Introduction, State description of digital processors, State description of sampled continuous time plants, State description of systems with dead time, Solution of difference equations, controllability and observability, Multivariable systems.

**4. POLE PLACEMENT DESIGN AND STATE OBSERVERS (8 HRS)**

Introduction, Stability improvement by state feedback, Necessary and sufficient conditions for arbitrary pole placement, State regulator design, Design of state observers, Compensator design by separation principle, State feedback with integral control, Digital control with state feedback, Deadbeat control by state feedback and deadbeat observers.

**5. DESIGN OF DIGITAL CONTROLLER (10 HRS)**

A brief review of three term controller and their realization, Implementation aspects: Refinement of three term algorithms, other controllers enhancement: linearization, Adaption, Sample rate selection, Consideration of computational accuracy, Phase lead lag controller, Pole zero cancellation, , Digital approximation of classical controllers, Effect of sampling, Different class of digital controllers, Ringing and placement of poles,

Design of optimal regulatory control systems, General synthesis method, Dead beat, Dahlin design, Kalman design, Predictive controller design, Internal-Model control.

**REFERENCES:**

1. M. Gopal, "*Digital Control and State Variable Methods*", Second Edition, Tata Mc Graw-Hil Publishing Company Limited, New Delhi, 1997.
2. Benjamin C. Kuo, "*Digital Control Systems*", Second Edition, Oxford University Press, 1995.
3. P. B. Deshpande and R. H. Ash, "*Computer Process Control with advanced control applications*", Second Edition, Instrument Society of America Publication, 1988.
4. G. Stephanopoulos, Chemical Process Control: "*An Introduction to Theory and Practice*", Prentice-Hall of India, 1998.
5. K. Ogata, "*Discrete-Time Control Systems*", Second Edition, Person Education Inc., New Delhi, 2002.
6. R. Isermann, "*Digital Control Systems*", Vol. I: Fundamentals, Deterministic Control, Springer-Verlag Publications.

**MECS203 - SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL**

Teaching Scheme:

Lecture - 03 Hrs.

Tutorial - 01Hrs.

Examination Scheme:

Theory Paper - 80 Marks

Class Test - 20 Marks

- 1. SYSTEM IDENTIFICATION (5 HRS)**  
 Purpose, Dynamic process models, System identification procedure, Direct methods: eyeball fitting, sine wave testing, Pulse testing, Step testing, ATV identification, Least-Squares method, state-estimators, Relationships among time, Laplace and frequency domains.
- 2. MODELS OF LINEAR TIME-INVARIANT SYSTEMS (5 HRS)**  
 Linear models and sets of linear models, A Family of transfer function models, State space models, Distributed parameter models, Model sets, Model structures, and Identifiability of some model structures.
- 3. MODELS OF LINEAR TIME-VARYING AND NONLINEAR SYSTEMS (8 HRS)**  
 Linear time varying models, Models with nonlinearities, Nonlinear state space models, Nonlinear black box models: basic principles, Models development using neural networks, fuzzy logic, wavelets and classical methods, Formal characterization of models, comparing linear and nonlinear model structures, model validation.
- 4. ADAPTIVE CONTROL (3 HRS)**  
 Introduction, Linear Feedback Control with effect of process variation, Adaptive schemes, Adaptive Control problems, Applications.
- 5. SELF TUNING REGULATORS (8 HRS)**  
 Introduction, Pole placement design, Indirect self-tuning regulators, Continuous –time self tuners, Direct self tuning regulators, effect of disturbances with known characteristics, Design of minimum variance and moving average controllers, Stochastic self tuning regulators, Direct self tuning regulators, Linear quadratic STR.
- 6. MODEL- REFERENCE ADAPTIVE SYSTEMS (6 HRS)**  
 Introduction, The MIT rule, determination of adaptation gain, Lyapunov theory, Design of MRAS using lyapunov theory, Bounded input Bounded output stability, Applications

to adaptive control, Output feedback, Relations between MRAS and STR, Nonlinear systems.

**7. GAIN SCHEDULING (5 HRS)**

Introduction, The basic principle, Design and implementation of gain scheduling controllers, nonlinear transformations, Adaptation of a feed forward gain, PID control, Auto tuning techniques, Applications.

**REFERENCES:**

1. Ljung "*System Identification: Theory for the User*" Second edition, Prentice Hall Information and System Sciences Series
2. Landau I. D., "*Adaptive Control: The Model Reference Approach*" Marcel Dekker, New York
3. Astrom K. J., and Bjorn Wittenmark "*Adaptive Control*" Second edition, Pearson education publications
4. Widrow B., and S. D. Stearns "*Adaptive Signal Processing*" Englewood Cliffs, N. J. Prentice Hall
5. Astrom K. J., J. J. Anton, and K. E. Arzen "*Expert Control*" *Automatica* 22(3):277-286

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## MECS204 - OPTIMAL CONTROL

Teaching Scheme:

Lecture - 03Hrs.

Tutorial - 01Hrs.

Examination Scheme:

Theory Paper - 80 Marks

Class Test - 20 Marks

### 1. OPTIMAL CONTROL SYSTEMS

(8 HRS)

Introduction, Parameter optimization: Servomechanism, Optimal control problems: Transfer function approach, State variable approach, State regulator problem, The Infinite time regulator problem, The output regulator & the tracking problems, Parameter optimization: Regulators.

### 2. OPTIMAL CONTROL PROBLEMS

(8 HRS)

Statement of optimal control problem- Problem formulation and types of optimal control- selection of performance measures, General model of feedback control systems, Transient performance analysis, Tracking performance analysis, Disturbances rejection analysis, cost functions and norms, Mathematical preliminary to optimal control.

### 3. LINEAR QUADRATIC OPTIMAL CONTROL THROUGH LYAPUNOV SYNTHESIS

(12 HRS)

Introduction, Concept of Lyapunov stability, Lyapunov functions for linear systems, Parameter optimization and optimal control problems, Quadratic performance index, Control configurations, Optimal state regulator, Optimal digital control systems, Constrained state feedback control, Matrix riccati equation and solution methods of state regulator and discrete systems-choice of weighting matrices-Linear Quadratic Gaussian Control- Kalman Filter, H<sub>2</sub> and H-infinite control and optimal estimation.

### 4. DYNAMIC PROGRAMMING

(5 HRS)

Principle of optimality, Recurrence relation of dynamic programming for optimal control problem, combinational procedure for solving optimal control problem.

### 5. DISCRETE TIME SYSTEMS

(7 HRS)

Solution of general discrete optimization problem, Discrete time linear quadratic regulator, Suboptimal feedback, Regulator problem with functions of final state fixed time optimal and fuel optimal control problems: minimum time control problem, Uniqueness of control: Bang bang control, Typical problems.

**REFERENCES:**

1. Brain D. O. Anderson, John B Moore, "*Optimal Control – Linear Quadratic Methods*", Prentice Hall of India, 1991.
2. Jeffrey B. Burf, "*Linear Optimal Control*", Addison - Wesley, California, 1999.
3. Frank L Lewis, John Wiley, "*Optimal Control*", New York, 1986.
4. Gopal M., Wiley Eastern, "*Modern Control System Theory*", New Delhi, 2nd Edition, 1993.
5. Kirk D.E., "*Optimal Control Theory: An Introduction*", Prentice Hall, New Jersey, 1970.

## MECS205 – EL-II INTELLIGENT INSTRUMENTATION

Teaching Scheme:

Lecture - 03 Hrs

Tutorial - 01 Hrs

Examination Scheme:

Theory Paper - 80 Marks

Class Test - 20 Marks

- 1. PROGRAMMABLE LOGIC CONTROLLERS (PLC) (8 HRS)**  
Introduction, architecture, discrete I/O systems, analog I/O systems, definition of discrete state process control, discrete state variables, event sequence description Ladder diagram, background, ladder diagram elements, ladder diagram symbols, development of ladder diagrams, functional block diagram, programming, advanced features, applications and study of at least one industrial PLC.
- 2. SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) (8 HRS)**  
Introduction, evaluation of SCADA, communication technologies, monitoring and supervisory functions, SCADA system components, schemes, remote terminal unit, intelligent electronic devices, communication network, SCADA server.
- 3. SCADA ARCHITECTURE (5 HRS)**  
Various SCADA Architectures, advantages and disadvantages of each system, single unified standard architecture IEC 61850 SCADA / HMI Systems.
- 4. SCADA COMMUNICATION ( 5 HRS)**  
Various industrial communication technologies- wired and wireless methods and fiber optics, open standard communication protocols.
- 5. OPERATION AND CONTROL OF INTERCONNECTED POWER SYSTEM (6 HRS)**  
Automatic substation control, SCADA configuration, energy management system, system operating states, system security, state estimation.
- 6. SCADA APPLICATIONS (5 HRS)**  
Utility applications, transmission and distribution sector operation, monitoring analysis and improvement, case studies, implementation, simulation exercises.
- 7. DISTRIBUTED CONTROL SYSTEM (8 HRS)**  
Introduction and overview, history, system architecture, system elements, data communication links, difference between centralized and distributed control system, overall tasks of digital control systems, detailed task listing. Displays: group display,

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overview display, detail display, local control units, mean time between failures, data Highways, field buses, multiplexers and remote sensing terminal units, I/O hardware, set point stations, study of TDC-3000, ABB MOD 300, Yokogawa Centum XL (at least one).

**TEXT BOOKS:**

1. Hughes, "*Programmable Controllers*", ISA Publications, 1989.
2. Stuart A Boyer, "*SCADA Supervisory Control and Data Acquisition*".
3. Gordan Clarke, Deon Reynders, "*Practical Modern SCADA Protocols*".
4. M. Lucas, "*Distributed Control Systems*".

**REFERENCES:**

1. B. G. Liptak, "*Instrument Engineer's Handbook, Process Control*", Third Edition, Chilton Book company, 1996.
2. C. D. Johnson, "*Process Control Instrumentation Technology*", Prentice- Hall of India, 1993.
3. Sunil S. Rao, "*Switchgear and Protections*", Khanna Publication.

**MECS205 - EL-II ROBUST CONTROL SYSTEM**

Teaching Scheme:

Lecture - 03 Hrs

Tutorial - 01 Hrs

Examination Scheme:

Theory Paper - 80 Marks

Class Test - 20 Marks

**1. INTRODUCTION (6 HRS)**

Some common robust control problems. Linear system tools: Jordan and Real Jordan canonical forms, structural decomposition.

**2. STRUCTURAL MAPPING OF BILINEAR TRANSFORMATIONS (8 HRS)**

Mapping of continuous time to discrete time and vice a versa, existence condition of  $H_{\infty}$  sub optimal controllers, continuous time system and discrete time system.

**3. SOLUTION TO DISCRETE TIME RICCATI EQUATIONS (8 HRS)**

Solutions to general DARE and  $H_{\infty}$ -DARE.

**4. INFORMATION IN CONTINUOUS TIME AND DISCRETE TIME  $H_{\infty}$  OPTIMIZATION (6 HRS)**

Full information feedback case, output feedback case, plants with imaginary axis zeros/unit circle zeros.

**5. SOLUTIONS TO CONTINUOUS TIME AND DISCRETE TIME  $H_{\infty}$  PROBLEMS (6 HRS)**

Full state feedback, full order output feedback, reduced order output feedback.

**6. TRACKING OF CONTINUOUS AND DISCRETE TIME SYSTEMS (6 HRS)**

Robust and perfect tracking of continuous time and discrete time systems, solvability conditions and solutions; solutions to measurement feedback case.

**TEXT BOOKS:**

1. Ben M. Chen, "*Robust and  $H_{\infty}$  Control*", Springer Verlag, London, 2000.
2. K. Zhon, John C. Doyle, "*Essentials of Robust Control*", Prentice Hall Int. 1998.

**REFERENCES:**

1. S. P. Bhattacharya, H. Chapellat, "*Robust Control - The Parametric Approach*", Prentice Hall Int. 1995.
2. Petros A. Ioannou, Jing Sun, "*Robust Adaptive Control*", Prentice Hall Int. Upper Saddle River, NJ07458.
3. M. Morari and E. Zafiriou, "*Robust Process Control*", Prentice Hall 1989
4. J. C. Doyle, B. A. Francis and A. R. Tannenbaum, "*Feedback Control Theory*", Macmillan 1992.
5. Francis, "*A Course in  $H_\infty$  Control Theory*".
6. "*Optimal Controller, A General Robust Control in Control System Toolbox:- Robust Analysis, Robust Model Reduction*", MATLAB, Mathwork Inc. 1992.

**MECS206 – NCT LAB.**

Teaching Scheme:

Practical - 4 Hrs/Week

Examination Scheme:

Termwork - 50 Marks

It shall consist of a minimum of 8 experiments based on the syllabus of Non-Linear Control Theory.

**MECS207 – ADCS LAB.**

Teaching Scheme:

Practical - 2 Hrs/Week

Examination Scheme:

Practical - 50 Marks

It shall consist of a minimum of 8 experiments based on the syllabus of Advance Digital Control Systems.

### **MECS208 - MINI PROJECT**

Teaching Scheme:

Practical - 2 Hrs/Week

Examination Scheme:

Practical - 50 Marks

The student will have to make a literature survey and should select a small project (as suggested by faculty adviser) relevant to Control System Engineering. The candidate should submit a comprehensive report on the work done and should deliver a seminar at the end of the semester which will be judged by two examiners and the marks will be given accordingly.

SEMESTER-III

**MECS301 - DISSERTATION (PART - I)**

Teaching Scheme

Practical - 12 Hrs/Week.

Examination Scheme:

Practical - 50 Marks

The dissertation Seminar will consist of a type written report covering the topic selected for Dissertation report. This should include the literature survey, technical details and related data required for the dissertation. The candidate shall deliver the dissertation seminar on the topic which will be judged by two examiners (one external and one internal guide) and the marks will be given accordingly.

SEMESTER-IV

**MECS401 - DISSERTATION (PART - II)**

Teaching Scheme

Practical -.20 Hrs/Week.

Examination Scheme:

Termwork - 50 Marks

Practical - 200 Marks

The practical Examination will consist of a presentation along with the demonstration of the dissertation work. The said examination will be conducted by a panel of two examiners (one internal guide and one external examiner).