HINDUSTAN UNIVERSITY

HINDUSTAN INSTITUTE OF TECHNOLOGY & SCIENCE

Department of Electronics and Instrumentation Engineering

M.Tech. Industrial Automation

Curriculum & Syllabus
2014 Regulations

ACADEMIC REGULATIONS
(M.TECH./ M.B.A. / M.C.A.)
(Full - Time / Part – Time)
(Effective 2014-15)

1. Vision, Mission and Objectives

1.1 The Vision of the Institute is "To make every man a success and no man a failure".

In order to progress towards the vision, the Institute has identified itself with a mission to provide every individual with a conducive environment suitable to achieve his / her career goals, with a strong emphasis on personality development, and to offer quality education in all spheres of engineering, technology, applied sciences and management, without compromising on the quality and code of ethics.

1.2 Further, the institute always strives

- To train our students with the latest and the best in the rapidly changing fields of Engineering, Technology, Management, Science & Humanities.
- To develop the students with a global outlook possessing, state of the art skills, capable of taking up challenging responsibilities in the respective fields.
- To mould our students as citizens with moral, ethical and social values so as to fulfill their obligations to the nation and the society.
- To promote research in the field of science, Humanities, Engineering, Technology and allied branches.

1.3 Our aims and objectives are focused on

- Providing world class education in engineering, technology, applied science and management.
- Keeping pace with the ever changing technological scenario to help our students to gain proper direction to emerge as competent professionals fully aware of their commitment to the society and nation.
- To inculcate a flair for research, development and entrepreneurship.

2. Admission

2.1. The admission policy and procedure shall be decided from time to time by the Board of Management (BOM) of the Institute, following guidelines issued by Ministry of Human Resource Development (MHRD), Government of India. The number of seats in each branch of the (M.TECH / M.B.A. / M.C.A.) programme will be decided by BOM as per the directives from Ministry of Human Resource Development (MHRD), Government of India and taking into account the market demands. Some seats for Non Resident Indians and a few seats for foreign nationals shall be made available.

2.2. The selected candidates will be admitted to the (M.TECH / M.B.A. / M.C.A.) programme after he/she fulfills all the admission requirements set by the Institute and after payment of the prescribed fees.

2.3. Candidates for admission to the first semester of the Master's Degree Programme shall be required to have passed an appropriate Degree Examination recognized by Hindustan University.

2.4. In all matters relating to admission to the (M.TECH /M.B.A. / M.C.A.).

Programme, the decision of the Institute and its interpretation given by the Chancellor of the Institute shall be final.

2.5. If at any time after admission, it is found that a candidate has not fulfilled any of the requirements stipulated by the Institute, the Institute may revoke the admission of the candidate with information to the Academic Council.

3. Structure of the programme

3.1. The programme of instruction will have the following structure

i) Core courses of Engineering / Technology / Management.

ii) Elective courses for specialization in areas of student's choice.

3.2. The minimum durations of the programmes are as given below:

Program	No. of Semesters
M.Tech.(Full-Time)	4
M.Tech.(Part -Time)	6
M.B.A. (Full - Time)	4
M.B.A. (Part - Time)	6
M.C.A.(Full - Time)	6
M.C.A.(Part -Time)	8

Every (M.TECH / M.B.A. / M.C.A.) programme will have a curriculum and syllabi for the courses approved by the Academic Council.

3.3. Each course is normally assigned certain number of credits. The following norms will generally be followed in assigning credits for courses.

- One credit for each lecture hour per week per semester;
- One credit for each tutorial hour per week per semester;
- One credit for each laboratory practical (drawing) of three (two) hours per week per semester.
- One credit for 4 weeks of industrial training and
- One credit for 2 hours of project per week per semester.

3.4. For the award of degree, a student has to earn certain minimum total number of credits specified in the curriculum of the relevant branch of study. The curriculum of the different programs shall be so designed that the minimum prescribed credits required for the award of the degree shall be within the limits specified below.

Program	Minimum prescribed credit range
M.Tech. (Full time / Part time)	75 - 85
M.B.A. (Full time / Part time)	85 - 95
M.C.A (Full time / Part time)	115 - 125

3.5. The medium of instruction, examination and the language of the project reports will be English.

4. Faculty Advisor

4.1. To help the students in planning their courses of study and for getting general advice on the academic programme, the concerned Department will assign a certain number of students to a Faculty member who will be called their Faculty Advisor.

5. Class Committee

5.1 A Class Committee consisting of the following will be constituted by the Head of the Department for each class:

(i) A Chairman, who is not teaching the class.

(ii) All subject teachers of the class.

(iii) Two students nominated by the department in consultation with the class.

The Class Committee will meet as often as necessary, but not less than three times during a semester.

The functions of the Class Committee will include:

(i) Addressing problems experienced by students in the classroom and the laboratories.

Range of Marks	Letter Grade	Grade points
95-100	S	10
85 - 94	A	09
75- 84	B	08
65-74	C	07
55-64	D	06
50-54	E	05
< 50	U	00
	I (Incomplete)	--

(ii) Analyzing the performance of the students of the class after each test and finding ways and means of addressing problems, if any.

(iii) During the meetings, the student members shall express the opinions and suggestions of the class students to improve the teaching / learning process.

6. Grading

6.1 A grading system as below will be adhered to.

6.2 GPA & CGPA

GPA is the ratio of the sum of the product of the number of credits C_i of course "i " and the grade points P_i earned for that course taken over all courses "i" registered by the student to the sum of C_i for all "i ". That is,

$$GPA = \frac{\sum_i C_i P_i}{\sum_i C_i}$$

CGPA will be calculated in a similar manner, at any semester, considering all the courses enrolled from first semester onwards.

6.3. For the students with letter grade I in certain subjects, the same will not be included in the computation of GPA and CGPA until after those grades are converted to the regular grades.

6.4 Raw marks will be moderated by a moderation board appointed by the Vice Chancellor of the University. The final marks will be graded using an absolute grading system. The Constitution and composition of the moderation board will be dealt with separately.

7. Registration and Enrollment

7.1 Except for the first semester, registration and enrollment will be done in the beginning of the semester as per the schedule announced by the University.

7.2 A student will be eligible for enrollment only if he/she satisfies regulation 10 (maximum duration of the programme) and will be permitted to enroll if (i) he/she has cleared all dues in the Institute, Hostel & Library up to the end of the previous semester and (ii) he/she is not debarred from enrollment by a disciplinary action of the University.

7.3. Students are required to submit registration form duly filled in.

8. Registration requirement

8.1. (i) A Full time student shall not register for less than 16 credits or more than 26 credits in any given semester.

8.1. (ii) A part time student shall not register for less than 10 credits or more than 20 credits in any given semester.

8.2 If a student finds his/her load heavy in any semester, or for any other valid reason, he/she may withdraw from the courses within three weeks of the commencement of the semester with the written approval of his/her Faculty Advisor and HOD. However the student should ensure that the total number of credits registered for in any semester should enable him/her to earn the minimum number of credits per semester for the completed semesters.

9. Minimum requirement to continue the programme

9.1. For those students who have not earned the minimum required credit prescribed for that particular semester examination, a warning letter to the concerned student and also to his parents regarding the shortage of his credit will be sent by the HOD after the announcement of the results of the university examinations.

10. Maximum duration of the programme

The minimum and maximum period for the completion of various programs are given below.

Program	Min. No. of Semesters	Max. No. of Semesters
M.Tech (Full - time)	4	8
M.Tech (Part - time)	6	10
M.B.A. (Full Time)	4	8
M.B.A. (Part Time)	6	10
M.C.A. (Full - Time)	6	12
M.C.A	8	14
(Part –Time)		

11. Temporary discontinuation

11.1. A student may be permitted by the Director(Academic) to discontinue temporarily from the programme for a semester or a longer period for reasons of ill health or other valid reasons. Normally a student will be permitted to discontinue from the programme only for a maximum duration of two semesters.

12. Discipline

12.1. Every student is required to observe discipline and decorum both inside and outside the campus and not to indulge in any activity which will tend to bring down the prestige of the University.

12.2. Any act of indiscipline of a student reported to the Director(Academic) will be referred to a Discipline Committee so constituted. The Committee will enquire into the charges and decide on suitable punishment if the charges are substantiated. The committee will also authorize the Director(Academic) to recommend to the Vice - Chancellor the implementation of the decision. The student concerned may appeal to the Vice Chancellor whose decision will be final. The Director(Academic) will report the action taken at the next meeting of the Council.

12.3. Ragging and harassment of women are strictly prohibited in the University campus and hostels.

13. Attendance

13.1. A student whose attendance is less than 75% is not eligible to appear for the end semester examination for that semester. The details of all students who have attendance less than 75% will be announced by the teacher in the class. These details will be sent to the concerned HODs and Dean.

13.2. Those who have less than 75% attendance will be considered for condonation of shortage of attendance. However a condonation of 10% in attendance will be given on medical reasons. Application for condonation recommended by the Faculty Advisor, concerned faculty member and the HOD is to be submitted to the Director(Academic) who, depending on the merits of the case, may permit the student to appear for the end semester examination. A student will be eligible for this concession at most in two semesters during the entire degree programme. Application for medical leave, supported by medical certificate with endorsement by a Registered Medical Officer, should reach the HOD within seven days after returning from leave or, on or before the last instructional day of the semester, whichever is earlier.

13.3. As an incentive to those students who are involved in extra curricular activities such as representing the University in Sports and Games, Cultural Festivals, and Technical Festivals, NCC/ NSS events, a relaxation of up to 10% attendance will be given subject to the condition that these students take prior approval from the officer –in-charge. All such applications should be recommended by the concerned HOD and forwarded to Director(Academic) within seven instructional days after the programme/activity.

14. Assessment Procedure

14.1. The Academic Council will decide from time to time the system of tests and examinations in each subject in each semester.

14.2. For each theory course, the assessment will be done on a continuous basis as follows:

Test / Exam	Weightage	Duration of Test / Exam
First Periodical Test*	10%	2 Periods
Second Periodical Test*	10%	2 Periods
Model exam	20%	3 hours
Seminar/ Assignments/Quiz	20%	
End – semester examination	50%	3 Hours

*** Best out of the two tests will be considered.**

14.3. For practical courses, the assessment will be done by the subject teachers as below:

(i) Weekly assignment/Observation note book / lab records – weightage 60%.
(ii) End semester examination of 3 hours duration including viva – weightage 40%.

15. Make up Examination/model examination

15.1. Students who miss the end-semester examinations / model examination for valid reasons are eligible for make-up examination /model examination. Those who miss the end-semester examination / model examination should apply to the Head of the Department concerned within five days after he / she missed examination, giving reasons for absence.

15.2 Permission to appear for make-up examination / model exam will be given under exceptional circumstances such as admission to a hospital due to illness. Students should produce a medical certificate issued by a Registered Medical Practitioner certifying that he/she was admitted to hospital during the period of examination / model exam and the same should be duly endorsed by parent / guardian and also by a medical officer of the University within 5 days.

16. Project evaluation

16.1. For Project work, the assessment will be done on a continuous basis as follows:

Review / Examination	Weightage
First Review	10%
Second Review	20%
Third Review	20%
End semester Examination	50%

For end semester exam, the student will submit a Project Report in a format specified by the Director(Academic). The first three reviews will be conducted by a Committee constituted by the Head of the Department. The end – semester examination will be conducted by a Committee constituted by the Controller of Examinations. This will include an external expert.

17. Declaration of results

17.1 A candidate who secures not less than 50% of total marks prescribed for a course with a minimum of 50% of the marks prescribed for the end semester examination shall be declared to have passed the course and earned the specified credits for the course.

17.2 After the valuation of the answer scripts, the tabulated results are to be scrutinized by the Result Passing Boards of PG programmes constituted by the Vice-Chancellor. The recommendations of the Result Passing Boards will be placed before the Standing Sub Committee of the Academic Council constituted by the Chancellor for scrutiny. The minutes of the Standing Sub Committee along with the results are to be placed before the Vice-Chancellor for approval. After getting the approval of the Vice-Chancellor, the results will be published by the Controller of Examination/Registrar.

17.3 If a candidate fails to secure a pass in a course due to not satisfying the minimum requirement in the end semester examination, he/she shall register and re-appear for the end semester examination during the following semester. However, the sessional marks secured by the candidate will be retained for all such attempts.

17.4 If a candidate fails to secure a pass in a course due to insufficient sessional marks though meeting the minimum requirements of the end semester examination, wishes to improve on his/her sessional marks, he/she will have to register for the particular course and attend the course with permission of the HOD concerned and the Registrar. The sessional and external marks obtained by the candidate in this case will replace the earlier result.

17.5 A candidate can apply for the revaluation of his/her end semester examination answer paper in a theory course within 2 weeks from the declaration of the results, on payment of a prescribed fee through proper application to the Registrar/Controller of Examinations through the Head of the Department. The Registrar/ Controller of Examination will arrange for the revaluation and the results will be intimated to the candidate concerned through the Head of the Department. Revaluation is not permitted for practical courses and for project work.

18. Grade Card

18.1. After results are declared, grade sheet will be issued to each student, which will contain the following details:

(i) Program and branch for which the student has enrolled.
(ii) Semester of registration.
(iii) List of courses registered during the semester and the grade scored.
(iv) Semester Grade Point Average (GPA)
(v) Cumulative Grade Point Average (CGPA).

19. Class / Division

19.1 Classification is based on CGPA and is as follows:
CGPA≥8.0: **First Class with distinction**
6.5 ≤CGPA < 8.0: **First Class**
5.0 ≤CGPA < 6.5: **Second Class.**

19.2 (i) Further, the award of 'First class with distinction' is subject to the candidate becoming eligible for the award of the degree having passed the examination in all the courses in his/her first appearance within the minimum duration of the programme.

(ii) The award of 'First Class' is further subject to the candidate becoming eligible to the award of the degree having passed the examination in all the courses within the below mentioned duration of the programme.

Program	No. of Semesters
M.Tech (Full - time)	5
M.Tech (Part - time)	7
M.B.A. (Full Time)	5
M.B.A. (Part Time)	7
M.C.A. (Full - Time)	7
M.C.A (Part –Time)	9

(iii) The period of authorized discontinuation of the programme (vide clause 11.1) will not be counted for the purpose of the above classification.

20. Transfer of credits

20.1. Within the broad framework of these regulations, the Academic Council, based on the recommendation of the transfer of credits committee so constituted by the Chancellor may permit students to earn part of the credit requirement in other approved institutions of repute and status in the country or abroad.

21. Eligibility for the award of (M.TECH / M.B.A. / M.C.A.) Degree

21.1. A student will be declared to be eligible for the award of the (M.TECH / M.B.A. / M.C.A.) Degree if he/she has
i) registered and successfully credited all the core courses,
ii) successfully acquired the credits in the different categories as specified in the curriculum corresponding to the discipline (branch) of his/her study within the stipulated time,
iii) has no dues to all sections of the Institute including Hostels, and
iv) has no disciplinary action pending against him/her.

The award of the degree must be recommended by the Academic Council and approved by the Board of Management of the University.

22. Power to modify

22.1. Notwithstanding all that has been stated above, the Academic Council has the right to modify any of the above regulations from time to time subject to approval by the Board of Management.

M.TECH. - INDUSTRIAL AUTOMATION
CURRICULUM 2014-2015

SEMESTER I

S.No	Course Code	Course Title	L	T	P	C	TCH
Theory							
1.	PMA106	Advanced Applied Mathematics *	3	1	0	4	4
2.	PPC101	Analog and Digital Instrumentation	3	1	0	4	4
3.	PPC102	Transducer Design	3	1	0	4	4
4.	PES102	Embedded System Design#	3	1	0	4	4
5.	PPC103	Communication Protocols for Instrumentation	3	1	0	4	4
6.	PVL102	Real Time Operating System**	3	1	0	4	4
Practical							
7.	PPC104	Embedded System Design Laboratory	0	0	3	1	3
		Total				**25**	**27**

*---Common to M.Tech (ES/PCI/CS/AE/CCE/VLSI)
#---Common to M.Tech (CS/ES/VLSI/PC&I/AE/EC)
**---Common to M.Tech (ES/PCI/EC)

SEMESTER II

S.No	Course Code	Course Title	L	T	P	C	TCH
Theory							
1.	PPD204	Linear and Non-Linear System Theory*	3	1	0	4	4
2.	PPC201	Programmable Logic Controller & Distributed Control Systems	3	1	0	4	4
3.	PIA 201	Advanced Control System	3	1	0	4	4
4.	PIA202	Intelligent Control	3	1	0	4	4
5	PIA203	Industrial Automation and Robotics	3	1	0	4	4
6.	PIA204	Process Dynamics and Control	3	1	0	4	4
Practical							
7.	PIA 211	Expert Systems Laboratory	0	0	3	1	3
	PIA212	Industrial Automation and Robotics Laboratory	0	0	3	1	3
		Total				**26**	**30**

*---Common to M.Tech (PCI/PED)

SEMESTER III

S.No	Course Code	Course Title	L	T	P	C	TCH
Theory							
1.	PIA3xx	Elective - I	3	1	0	4	4
2.	PIA3xx	Elective – II	3	1	0	4	4
3.	PIA3xx	Elective - III	3	1	0	4	4
Practical							
4.	PIA305	Project Phase- I	0	0	12	6	12
		Total				**18**	**24**

List of Electives

Elective - I

S.No	Course Code	Course Title	L	T	P	C	TCH
1.	PIA321	SCADA Systems and Applications	3	1	0	4	4
2.	PIA322	Data Acquisition Systems	3	1	0	4	4
3.	PIA323	Advanced Sensor Technology	3	1	0	4	4

Elective – II

S.No	Course Code	Course Title	L	T	P	C	TCH
Theory							
1.	PIA324	System Identification and Control	3	1	0	4	4
2.	PIA325	Multi-Variable Control	3	1	0	4	4
3.	PIA326	Fault Detection and Diagnosis	3	1	0	4	4

Elective - III

S.No	Course Code	Course Title	L	T	P	C	TCH
Theory							
1.	PIA327	Computer Control of Manufacturing Systems	3	1	0	4	4
2.	PIA328	Mechatronics in manufacturing Systems	3	1	0	4	4
3.	PIA329	Process Consulting And Project Planning	3	1	0	4	4
4.	PIA330	Advanced Adaptive Control Systems	3	1	0	4	4

SEMESTER IV

S.No	Course Code	Course Title	L	T	P	C	TCH
Practical							
1.	PIA406	Project Phase-II	0	0	24	12	24
		Total				**12**	**24**

Total Credits: 81

SEMESTER I

[Common to M.Tech (ES/PCI/CS/AE/CCE and VLSI)]

PMA106	**ADVANCED APPLIED MATHEMATICS**	**4 Credits**
Goal	Develop the Mathematical skills to formulate certain practical problems, solve them and physically interpret the results	

Objectives	**Outcomes**
The course should enable the student to 1. Understand the techniques to solve the system of equations using direct method and indirect methods. Learns to decompose the matrix in the LU form and to find the Eigen value of a matrix using power and Jacobi methods. 2. Learn to classify the initial and boundary value problems. Understands the D'Alemberts solution of the one dimensional wave equation. Learn significance of characteristic curves. 3. Learn series solutions of Bessel's and Legendre equations. Understand recurrence relation, generating functions and orthogonal properties. 4. Learn basics of probability, addition and multiplication, Baye's theorems. Understands the concept of random variable, moment generating function and their properties. Learn standard distributions in discrete and continuous cases 5. Learns the different Markovian models with finite and infinite capacity and understands to classify them.	The students should be able to: 1. Able to write the algorithm for solving the simultaneous equations for direct and indirect methods. Identifies the Eigen values using conventional method and compares with numerical solutions. Able to write the algorithm to find the Eigen values of a matrix. 2. Able to form the wave equations with initial conditions and solve them using D'Alemberts solutions. Solves the wave equations using Laplace transform for displacements in long string – long string under its weight and free and forced vibrations. 3. Solves the Bessel's equation and Legendre equations. Using Bessel's function solves many practical problems that arise in electrical transmission problems and vibration of membranes as in loudspeakers. 4. Evaluates the probability using addition and multiplication theorem. Applies Baye'sfor practical problems to find the probability. Verifies whether a given function is a probability mass or density function. Applies the discrete and continuous distributions for solving practical problems. Evaluates the moments of the distributions using moment generating function. 5. Able to analyze and classify the models, M / M / 1, M / M / C, finite and infinite capacity and solves practical problems related to the queuing models.

UNIT-I: - LINEAR ALGEBRAIC EQUATION AND EIGEN VALUE PROBLEMS 12

System of Equations – Solution by Gauss Elimination and Gauss Jordan methods – LU decomposition method – Indirect methods – Gauss Jacobi and Gauss Seidel methods – Eigen values of a matrix using Jacobi and power methods.

UNIT-II: - WAVE EQUATION 12

Solution of initial and boundary value problems - Characteristics - D'Alembert's solution - Significance of characteristic curves - Laplace transform solutions for displacement in a long string, in a long string under its weight - a bar with prescribed force on one end - Free vibrations of a string.

UNIT-III: - SPECIAL FUNCTIONS **12**

Series solutions - Bessel's equation - Bessel functions - Legendre's equation - Legendre polynomials - Rodrigue's formula - Recurrence relations - Generating functions and orthogonal property for Bessel functions of the first kind - Legendre polynomials.

UNIT-IV: - PROBABILITY AND RANDOM VARIABLE **12**

Discrete and Continuous random variables – Moments – Moment generating functions - Standard distributions - Binomial, Poisson, Geometric, Negative Binomial, Uniform, Normal ,Exponential, Gamma and Weibull distributions – Two dimensional random variables – Joint, Marginal and Conditional distributions. Correlation and Regression.

UNIT-V: - QUEUING THEORY **12**

Markovian models – Birth and death queuing models – Steady state – Single and Multiple servers – M/M/1 – Finite and infinite capacity – M/M/C – finite and infinite capacity.

L = 45 T = 15 TOTAL: 60

REFERENCE BOOK

1) Taha, H.A., "Operations Research - An Introduction ", Prentice Hall of India Ltd., 6th Edition, New Delhi, 1997.
2) Dr.Singaravelu A., Dr.Siva Subramanian S., and Dr.Ramachandran C., "Probability and Queuing Theory", Meenakshi agency, 20th edition, January 2013.
3) Veerarajan T., "Probability, Statistics and Random Processes", Tata McGraw-Hill, second edition, 2004.
4) Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 34th edition.
5) Sankara Rao K., "Introduction to Partial Differential Equations", PHI, 1995.
6) Veerarajan T., "Mathematics IV", Tata McGraw-Hill, 2000.

PPC101	**ANALOG AND DIGITAL INSTRUMENTATION**	**4 CREDITS**
Goal	The goal of the programme is to provide a thorough knowledge about different types of Data Acquisition systems and about different communication systems used in industry.	

Objectives	**Outcome**
The course should enable the students : 1. To study the different type of A/D converters. 2. To make them understand the building blocks of Automation systems and various Data Acquisition Systems& Data loggers. 3. To assist the learners in understanding about different types of interfacing and transmission systems. 4. To learn the different types of communication protocols such as HART, Field bus, General Field bus architecture, Instrumentation buses, Mod bus, GPIB, Network buses, Ethernet,	The students should be able to: 1. The learners will have the confidence on how to select the A/D converter for different application. 2. The learners will be able to know the difference between single channel and multi-channelData Acquisition Systems and can use this knowledge in sensor based acquisition systems. 3. The learners will be able to understand TDM, Digital Modulation, Pulse Modulation and different interfacing system standards. 4. The learners will be able to understand the different communication protocols that industries are

TCP/IP protocols. 5. Tolearn the real time Data Acquisition syste applications for the case studies.	following. 5. The learners will have the basic idea of PC based industrial process measurements like flow, temperature, pressure and level systems.

UNIT-I: - BASIC BLOCKS **12**

Overview of A/D converter, types and characteristics-Understanding Data acquisition, A/D and S/H terms-passive support and Active support components-Single and Multi-slope, Low cost A/D conversion techniques, types-Electromechanical A/D converter.

UNIT-II: - DATA ACQUISITION SYSTEMS **12**

Objective - Building blocks of Automation systems – Multi, Single channel Data Acquisition systems, PC based DAS, Data loggers- Sensors based computer data systems.

UNIT-III: - INTERFACING AND DATA TRANSMISSION **12**

Data transmission systems- 8086 Microprocessor based system design - Peripheral Interfaces – Time Division Multiplexing (TDM) – Digital Modulation – Pulse Modulation – Pulse Code Format – Interface systems and standards – Communications.

UNIT-IV: - PC BASED INSTRUMENTATION **12**

Introduction - Evolution of signal Standard - HART Communication protocol -Communication modes - HART networks - control system interface - HART commands -HART field controller implementation - HART and the OSI model - Field bus –Introduction - General field bus architecture - Basic requirements of field bus standard -field bus topology - Interoperability –Interchangeability - Instrumentation buses-Mod bus - GPIB - Network buses – Ethernet - TCP/IP protocols

UNIT-V: - CASE STUDIES **12**

PC based industrial process measurements like flow, temperature, pressure and level – PC based instruments development system.

L = 45 T = 15 TOTAL: 60

REFERENCE BOOK

1. Kevin M. Daugherty, "Analog – to – Digital conversion – A Practical Approach", McGraw Hill International Editions, 1995
2. N. Mathivanan, "Microprocessors, PC Hardware and Interfacing", Prentice – Hall of India Pvt. Ltd., 2003.
3. Krishna Kant "Computer- based Industrial Control", Prentice- Hall of India Pvt. Ltd., 2004.
4. H S. Kalsi, "Electronic Instrumentation", Technical Education Series Tata McGraw-Hill, 2004.
5. Buchanan, "Computer busses", Arnold, London, 2000.

PPC102	**TRANSDUCER DESIGN**	4 CREDITS
Goal	To provide basic knowledge about various sensors, its selection criteria and their Applications	
Objectives	**Outcome**	

The course will enable the students :	The students should be able to:
1. To impart knowledge about the various sensors used for measuring physical parameters. 2.Emphasis on signal processing, converting and presenting it to monitoring /controlling instruments. 3. To acquire knowledge design of electro mechanical transducers for heavy machinery devices. 4. To acquaint them with various transducers used for measurement in various environment.	1. Understand the basic principles of sensors used for measuring physical parameters. 2. Design signal conditioning circuits and monitor parameters. 3. To design/ select electro-mechanical transducers used in air craft and ship industries. 4. Choose and apply transducer for various environments.

UNIT-I: - FUNDAMENTALS **12**

Review of Fundamentals of Transducers for measurement of: Physical parameters like. Displacement, Pressure, Force, Flow, Stress, Strain, Velocity, Vibration, Torque, Temperature, pH, Conductivity, Proximity sensors, Chemical parameters, Biomedical parameters like. Pathological parameters, Detection of alpha, beta and gamma radiation.

UNIT-II: - SIGNAL CONDITIONERS **12**

Review of signal conditioners for: Strain Gauge Transducers, Inductive Transducers, Magnetic, Magneto-strictest, Piezo Electric Transducers, Optical Transducers, Capacitive Transducers, Vibrating wire, Review of Processors for Analog and Digital Signals, Review of Various Input and Output Display Systems

UNIT-III: - ELECTROMECHANICAL TRANSDUCERS **12**

Design of Electromechanical Transducers for: Force, Pressure, Stress, Vibration using ,Strain-gauge, LVDT , Capacitive Elements, Optical Device, Application in design case, such as measurements for Hydraulic and Pneumatic Machinery like Turbines, Aircraft Systems and Ship Machinery

UNIT-IV: - SELECTION CRITERIA & APPLICATION **12**

Discussion of Selection Criteria for each of above cases: Design of Electromechanical Transducers for Torque, Flow and Velocity. Application in design case from Automobile for Torque, Liquid Flow for Flow and Velocity. Inclination/Tilt, Rotation and Gyration of Machinery like Winches, Earth Movers, and Fork lifts, Giant Wheels, Space Craft etc. Discussion on design criteria for three component and six component dynamometers both pure mechanical and electromechanically designs. Discussion on Multi-output (including digital) Transducers for various applications.

UNIT-V: - CASE STUDIES **12**

Case Studies for: Chemical Sensors, Bio sensors, Gas Sensors. Discussions on Nano Sensors and MEMS applications. Application of LASER for various measurements like: alignment, distance, velocimetry for convection and liquid flow, angular rotation. Applications of LASER for micromachining, printing and compact discs like CD and DVD, Weapons, welding, surface hardening, cutting, nuclear fusion.

L = 45 T = 15 Total = 60

REFERENCE BOOK

1. H K P Neubert, 'Instrument Transducers', Oxford University Press, 1999
2. Bella G Liptak, 'Instrument Engineers Handbook, Vol 1, 2 and 3', 4th edition, CRC Press, 2005.
3. C.S. Rangan, G.R. Sarma and V.S.V. Mani 'Instrumentation Devices and Systems', Tata McGraw-Hill Publishing Company Ltd. New Delhi, 2004.
4. J. Wilson, J.F.B. Hawkes, 'Laser Principles and Applications', Prentice-Hall, New York, 1987.
5. J. Wilson, 'Optoelectronics', 2nd Edition, Prentice-Hall, India. 2003.

PES102	EMBEDDED SYSTEN DESIGN	4 CREDITS
Goal	The aim of this course is to expose the concepts of Embedded system principles and software development tools and introducing PIC and Motorola microcontrollers and interfacing.	

Objectives	Outcome
The course should enable the students to: 1. Understand the use of review in embedded hardware. 2. Understand basic concepts of design of Embedded software system, 3. Understand the Software architecture and Developments tools 4. Understand the Operation of PIC microcontroller and interfacing 5. Understand the Operation of Embedded Microcomputer systems	At the end of the course the student should be able to: 1. Use of hardware fundamentals.Gates,timing diagram,DMA,interrupts,built ins on the microprocessor and microprocessor architecture. 2. Explain the concept of Tasks,States,Data,Semaphores,more operating system servicesIR in RTOS environment,Basic design using RTOS, 3. Develop through basic knowledge on the behavior and the characteristics of Round-Robin techniques,Functions,Queue,Host and Target machine and Debugging techniques, 4. Learn the usage of Architecture,instruction sets of PIC, Loop time subroutine,I/O port expansion,I2C for peripherals chip access,ADC and UART special features, 5. Acquire knowledge on the configuration of Motorola,Registers,addressing modes,interfacingmethods,ISR,Timing generations and measurements .

.

UNIT-I: - INTRODUCTION: REVIEW OF EMBEDDED HARDWARE 12

Hardware Fundamentals: Terminology- Gates- Timing Diagram- Microprocessors- Buses- Direct Memory Access- Interrupts- Other Common Parts- Built-Ins on the Microprocessor-Conventions Used on Schematics. Interrupts: Microprocessor Architecture - Interrupts Basics-Shared-Data Problem- Interrupt Latency, Examples of Embedded System.

UNIT-II: - DESIGN OF EMBEDDED SOFTWARE SYSTEM 12

Introduction: Tasks and Task States- Tasks and Data- Semaphores and Shared Data. More Operating System Services: Message Queues- Mailboxes and Pipes- Timer Functions- Events- Memory Management- Interrupt Routines in an RTOS Environment, Basic Design Using a Real-Time Operating System.

UNIT-III: - SOFTWARE ARCHITECTURES AND DEVELOPMENT AND TOOLS 12

Software Architectures: Round-Robin- Round-Robin with Interrupts- Function-Queue-Scheduling Architecture- Real-Time Operating System Architecture, Development Tools: Host and Target Machines- Linker/Locators for Embedded Software, Debugging Techniques.

UNIT-IV: - PIC MICROCONTROLLER AND INTERFACING 12

Introduction- CPU Architecture and Instruction Set- Loop Time Subroutine- Timer2 and Interrupts- Interrupts Timing- I/O Port Expansion- I2C Bus for Peripheral Chip Access- Analog-to- Digital Converter- UART- Special Features.

UNIT-V: - EMBEDDED MICROCOMPUTER SYSTEMS 12

ARM 7 Family Architecture - Registers- Addressing Modes. Interfacing Methods: Parallel I/O Interface- Parallel Port Interfaces- Memory Interfacing- High Speed I/O interfacing-Analog interfacing, Interrupts, Interrupts Service Routine- Features of Interrupts- Interrupt Vector and Priority, Timing Generation and Measurements: Input Capture- Output Compare- Frequency Measurement, Serial I/O Devices: RS232- RS485.

L = 45, T = 15, TOTAL= 60

REFERENCE BOOK

1. David E Simon, An Embedded Software Primer, Pearson Education Asia, 2001
2. John B. Peat man , Design with Microcontroller, Pearson Education Asia, 1998
3. Jonarthan W. Valvano Brooks/Cole ,Embedded Micro Computer Systems, Real Time Interfacing, Thomson Learning 2001
4. Burns, Alan and Wellings, Andy, Real-Time Systems and Programming Languages, Second Edition, Harlow: Addison-Wesley-Longman, 1997
5. Raymond J.A. Bhur and Donald L.Bialey, An Introduction to Real Time Systems: Design to Networking with C/C++, Prentice Hall Inc, New Jersey, 1999
6. Grehan Moore, and Cyliax, Real Time Programming: A Guide to 32 Bit Embedded Development. Reading: Addison-Wesley-Longman, 1998
7. Heath, Steve, Embedded Systems Design. Newnes , 1997

PPC103	**COMMUNICATION PROTOCOLS FOR INSTRUMENTATION**	**4 CREDITS**
Goal	The aim of this course is to give exposure to Hierarchical Structure of networks used in Automation and Control Systems and Understand the ISO OSI Seven Layer Communication Structure, Communication interfaces, Ethernet, Communication protocols.	

Objectives	**Outcome**
The course should enable the students : 1. To understand the use of Communication Model for recent Industry Networks. 2. To widen the knowledge on Communication Protocols. 3. To learn about the Network Architectures. 4. To expand knowledge on Field Bus. 5. To enrich expertise on the commissioning of Industrial Networks. systems	At the end of the course the student should be able to: 1. Explain the concept of communication model, OSI reference model, Recent Industry networks. 2. Classify the Network selection applicable for specific industrial needs. 3. Differentiate the Network Architecture and understand the concepts of Industrial protocols like Ethernet, Modbus, and Modbus Plus. 4. Design and install Field Bus oriented Industrial Communication Networks. 5. Calibrate the smart devices using Profibus and Field Bus of any Industrial Application

UNIT-I: - INTRODUCTION **12**

An Introduction to Networks in process automation: Information flow requirements, Hierarchical communication model, Data Communication basics, OSI reference model, Industry Network, Recent networks.

UNIT-II: - COMMUNICATION PROTOCOLS **12**

Introduction to Communication Protocols: Communication basics, Network Classification, Device Networks, Control Networks, Enterprise Networking, Network selection.

UNIT-III: - NETWORK ARCHITECTURES **12**

Proprietary and open networks: Network Architectures, Building blocks, Industry open protocols (RS-232C, RS- 422, and RS-485), Ethernet, Modbus, Modbus Plus, Data Highway Plus, Advantages and Limitations of Open networks, IEEE 1394.

UNIT-IV: -FIELD BUS **12**

Field bus: Field bus Trends, Hardware selection, Field bus design, Installation, Documentation, Field bus advantages and limitations. HART: Introduction, Design, Installation, calibration, commissioning, Application in Hazardous and Non-Hazardous area.

UNIT-V: - PLANNING AND COMMISSIONING **12**

Foundation Field bus & Profibus: Introduction, Design, Calibration, Commissioning, Application in Hazardous and Non-Hazardous area. Introduction to wireless Protocols: WPAN, Wi-Fi, Bluetooth, ZigBee, Z-wave.

L = 45 T = 15 Total = 60

REFERENCE BOOK

1. B.G. Liptak, 'Process Software and Digital Networks, CRC Press ISA-, 2002.
2. RomillyBowden,'HART Communications Protocol', Fisher-Rosemount, 2003.
3. User Manuals of Foundation Field bus, Profibus, Modbus, Ethernet, Device net, and Control net.

PVL102	**Real Time Operating System**	**4 CREDITS**
Goal	To develop in-depth skills in Real Time Operating Systems.	
Objectives		**Outcome**
The course will enable the students to: 1. Review Operating Systems. 2. Understand about Distributed Operating Systems. 3. Learn Real Time Models and Languages. 4. Understand about introduction to Real Time Kernels. 5. Understand about RTOS and Application Domains.		After completion of the course the students are expected to : 1. Explain various operating systems 2. Explain Basic building blocks of Real time Operating Systems. 3. Interface various peripherals to RTOS. 4. Program Real time Systems. 5. Develop Real time Systems.

UNIT-I: -REVIEW OF OPERATING SYSTEMS **12**

Basic Principles-system calls-Files-Processes-Design and implementation of processes- Communication between processes operating system structures.

UNIT-II: - DISTRIBUTED OPERATING SYSTEMS **12**

Topology-Network Types-Communication-RPC-Client server model- Distributed file systems.

UNIT- III:-REALTIME MODELS AND LANGUAGES **12**

Event based-Process based-Graph models-Petrine tmodels-RTOS tasks-RTOS scheduling– Interrupt processing-Synchronization-Control blocks-Memory requirements.

UNIT- IV:-REAL TIME KERNEL **12**

Principles – Polled loop systems-RTOS porting to a target-Comparison and Study of RTOS– VX Works and µCoS, Introduction to POSIX and OSEK standards.

UNIT- V:-RTOS AND APPLICATION DOMAINS **12**

RTOS for Control-Embedded RTOS for Control over IP - RTOS for fault tolerant applications -RTOS for control systems.

L= 45 T=15 TOTAL=60

REFERENCE BOOK

1. Hermann K, 'Real *time systems-design principles for distributed embedded Applications'*, Kluwer academic, 1997.
2. CharlesCrowley'*operatingsystems-Adesignorientedapproach'*McGrawHill,1998
3. AJBUHR, DL Beily, 'An *introduction to real time systems'*PHI, 1999
4. CM Krishna, Kang G. Shin, '*Real time Systems'*, Mc GrawHill, 1997
5. Raymond J.A., Donald L Baily, 'An *introduction to real time operating systems'*PHI, 1999

PPC104	**EMBEDDED SYSTEM DESIGN LABORATORY**	**1 CREDITS**
Goal	The aim of this course is to train students with skills in Designing of Embedded based systems required for Industrial Automation and Control Systems.	

Objectives	**Outcome**
The course should enable the students : 1. To understand the register architecture of Atmel 8051,PIC 16f877A Microcontroller. 2. To widen the knowledge on interfacing various serial Communication Protocols. 3. To learn about interfacing various parallel communication protocols. 4. To expand knowledge on Interfacing Digital Input and Output. 5. To develop expertise on Interfacing the Analog input and output.	At the end of the course the student should be able to: 1. Explain the organization of Registers, Memory and Instruction set with the knowledge of Addressing modes which help the student to develop program sequence for any industrial application. 2. Communicate with any device using USART Configurable Communication Interface. 3. Interface the Parallel/Serial LCD Interface and Alphanumerical Keyboard Interface. 4. Design a complete Data acquisition system with Analog sensor interface and Digital sensors. 5. Simulate the complete embedded application using Virtual Simulation Software (Proteus)

LIST OF EXPERIMENTS

1. System Design Study using Atmel, PIC Microcontrollers.
2. System Design for interfacing various parallel communication protocols.
3. System Design for interfacing various serial communication protocols.
4. System Design for Digital Input and Output (includes Virtual Simulation)
5. System design for Analog input and output. (includes Virtual Simulation)

P=45 TOTAL=45

SEMESTER II

PPD204	**LINEAR AND NON - LINEAR SYSTEM THEORY** **Common to M.Tech. (PC&IE) / M.Tech. (EC)/ M.Tech. (PSE)**	**4 CREDITS**
Prerequisite	Control Systems	
Goal	To provide an insight theory on linear and nonlinear control systems.	

Objectives	**Outcome**
The course should enable the students to: 1. Study the concept of state space representation of dynamic systems. 2. Study about solution of state equations of linear, nonlinear, time invariant and time varying systems and also about systems modes. 3. Know about the concepts of controllability, Observability, detectability, stabilizability and reducibility of time invariant and time varying systems. 4. Have an in-depth knowledge about stability of linear and nonlinear systems using Liapunov's criterion. 5. Study the concept of observable and controllable companion forms and pole placement by feedback for SISO and MIMO systems.	At the end of the course the student should be able to: 1. Derive state space equations and draw state diagrams for physical systems 2. Solve state equations of linear, nonlinear, time invariant and time varying systems, 3. Verify if a given system is controllable, observable, detectable, stabilizable and reducible. 4. Verify if a given system is stable using Liapunov's criterion. 5. Develop observable and controllable companion forms for a given system.

UNIT I STATE VARIABLE REPRESENTATION` 12

Introduction-Concept of State-State equation for Dynamic Systems-Time invariance and linearity-Non uniqueness of state model-State Diagrams-Physical System and State Assignment.

UNIT II SOLUTION OF STATE EQUATION 12

Existence and uniqueness of solutions to Continuous-time state equations-Solution of Nonlinear and Linear Time Varying State equations-Evaluation of matrix exponential-System modes-Role of Eigenvalues and Eigenvectors.

UNIT III CONTROLLABILITY AND OBSERVABILITY 12

Controllability and Observability-Stabilizability and Detectability-Test for Continuous time Systems- Time varying and Time invariant case-Output Controllability-Reducibility-System Realizations.

UNIT IV STABILITY 12

Introduction-Equilibrium Points-Stability in the sense of Lyapunov-BIBO Stability-Stability of LTI Systems-Equilibrium Stability of Nonlinear Continuous Time Autonomous Systems-The Direct Method of Lyapunov and the Linear Continuous-Time Autonomous Systems-Finding Lyapunov Functions for Nonlinear Continuous Time Autonomous Systems-Krasovskii and Variable-Gradient Method.

UNIT V MODAL CONTROL 12

Introduction-Controllable and Observable Companion Forms-SISO and MIMO Systems-The Effect of State Feedback on Controllability and Observability-Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order and Reduced Order Observers.

L = 45 T = 15 Total = 60

REFERENCE BOOK

1. M. Gopal, "Modern Control System Theory", New Age International, 2005.
2. K. Ogatta, "Modern Control Engineering", PHI, 2002.
3. John S. Bay, "Fundamentals of Linear State Space Systems", McGraw-Hill, 1999.
4. D. Roy Choudhury, "Modern Control Systems", New Age International, 2005.
5. John J. D'Azzo, C. H. Houpis and S. N. Sheldon, "Linear Control System Analysis and Design with MATLAB", Taylor Francis, 2003.
6. Z. Bubnicki,"Modern Control Theory", Springer, 2005.

PPC201	**PROGRAMMABLE LOGIC CONTROLLER & DISTRIBUTED CONTROL SYSTEMS**	4 CREDITS
Goal	The goal of the programme is to acquaint the student with basic programming skills of PLC and DCS so that they will be able get an insight of industrial Process Control scenario.	

Objectives	**Outcome**
The course should enable the students : 1. To get a sound knowledge on digital data acquisition devices and digital controllers. 2. To learn about the basic building blocks of PLC, basic commands and functions. 3. To know the various functions for programming PLC 4. To know about the various interfacing devices Bus Standards to PLC and DCS. 5. To know the basic concepts in DCS	The students should be able to: 1. Design digital acquisition devices and digital controllers 2. Program PLC for simple applications using Timers and Counters. 3. Program PLC using Intermediate functions 4. Design interfacing system for PLC and DCS. 5. Understand the architectures of DCS environment.

Unit I:-**Review of computers in process control**: **12**

Data loggers, Data Acquisition Systems (DAS), Direct Digital Control (DDC). Supervisory Control and Data Acquisition Systems (SCADA), sampling considerations. Functional block diagram of computer control systems. Alarms, interrupts. Characteristics of digital data, controller software, linearization. Digital controller modes: Error, proportional, derivative and composite controller modes.

Unit II: - Programmable logic controller (PLC) basics: **12**

Definition, overview of PLC systems, input/output modules, power supplies, isolators. General PLC programming procedures, programming on-off inputs/ outputs. Auxiliary commands and functions: PLC Basic Functions: Register basics, timer functions, counter functions.

Unit III:-PLC intermediate functions: **12**

Arithmetic functions, number comparison functions, Skip and MCR functions, data move systems. PLC Advanced intermediate functions: Utilizing digital bits, sequencer functions, matrix functions. PLC Advanced functions: Alternate programming languages, analog PLC operation, networking of PLC, PLC-PID functions, PLC installation, troubleshooting and maintenance, design of interlocks and alarms using PLC. Creating ladder diagrams from process control descriptions.

Unit IV: - Interface and backplane bus standards for instrumentation systems Field bus: **12**

Introduction, concept. HART protocol: Method of operation, structure, operating conditions and applications. Smart transmitters, examples, smart valves and smart actuators.

Unit V: - Distributed control systems (DCS): **12**

Definition, Local Control (LCU) architecture, LCU languages, LCU - Process interfacing issues, communication facilities, configuration of DCS, displays, redundancy concept- case studies in DCS.

L = 45 T = 15 Total = 60

REFERENCE BOOK

1. John. W.Webb Ronald A Reis , Programmable Logic Controllers – Principles and Applications, Third edition, Prentice Hall Inc., New Jersey, 1995.
2. Lukcas M.P Distributed Control Systems, Van Nostrand Reinhold Co., NewYork, 1986.
3. Deshpande P.B and Ash R.H, Elements of Process Control Applications, ISAPress, New York, 1995.
4. Curtis D. Johnson, Process Control Instrumentation Technology, Fourthedition, Prentice Hall of India, New Delhi, 1999.

PIA201	**ADVANCED CONTROL SYSTEM**	**4 CREDITS**
Goal	The goal of the programme is to review Process Modeling and Classical Control Theory concepts, analyze and design of control schemes in the continuous and discrete-time domain.	

Objectives	**Outcome**
The course should enable the students to : 1. Study the linear dynamic models for advanced control systems 2. Understand the State Space analysis of continuous time systems. 3. To assist the learners in understanding Observer design and kalman's filtering. 4. To learn the state feedback controller design methods. 5. To learn the Model Predictive Control.	The students should be able to: 1. Develop a state space model for a given transfer function and be able to convert into controllable canonical or observable canonical or diagonal canonical form. 2. Analyze State Space analysis of continuous time systems. 3. Design observer for systems and implement kalman filtering for systems. 4. Provide solutions and design state feedback controllers. 5. Design and develop Model Predictive Control for various process systems.

Unit I: Linear Dynamic Models for Advanced Control **12**

Dynamic models in chemical engineering and linearization. Linear continuous time state space models and Laplace Transfer function matrix representation. Computer oriented (or discrete time) state space models and z-transfer function matrix representation. Development of discrete time state space models from input-output data (development of OE and ARMAX models, state realizations)

Unit II: Analysis of State Space Models **12**

State transformations, poles and zeros, characteristic equation. Solution of unforced and forced linear differential and difference equations and asymptotic behavior of solutions. Lyapunov stability analysis.

Unit III: Observer design **12**

Observability and observervable canonical form, Luenberger (SISO) observer and pole placement design, Prediction and current state observer, reduced order observer. Observer design in presence of state and measurement noise, Kalman filtering and optimal state estimation, convergence of observer error connection between Kalman filter and linear time series models.

Unit IV: State feedback controller design **12**

Controllability, reachability and controllable canonical form. State feedback controller for SISO systems design by pole placement, difficulties in extending to multivariable systems. Linear quadratic optimal control (Derivation of Riccati equations, set point tracking and disturbance rejection, stability analysis). Separation Principle and state feedback control using state observers. Examples of state LQ and LQG.

Unit V: Model Predictive Control **12**

Limitations of LQ control and operating constraints. Dynamic matrix control (state space formulation, nconstrained solution, QP formulation), Internal Model Control. Model predictive control (MPC) based on state estimation (Kalman filtering). Nominal stability and robustness of MPC. MPC case study. Beyond linear multivariable control.

L = 45 T = 15 Total = 60

REFERENCE BOOK

1. Astrom, K. J. and B. Wittenmark, Computer Controlled Systems, PrenticeHall, 1990.
2. Franklin, G. F. and J. D. Powell, Digital Control of Dynamic Systems, Addison-Wesley, 1989.
3. Graham C. Goodwin, Stefan F. Graebe, Mario E. Salgado, Control SystemDesign, Prentice Hall, 2000.

PIA202	**INTELLIGENT CONTROL**	**4 CREDITS**
Goal	Students completing this course will obtain a basic understanding of fuzzy logic systems and artificial neural networks, and will know how these techniques are applied to engineering problems, including control systems. Students will understand the advantages and disadvantages of these methods relative to other control methods. Students will be aware of current research trends and issues. Students will be able to design control systems using fuzzy logic and artificial neural networks.	

Objectives	**Outcome**
The course should enable the students to : 1. Obtain a basic understanding of fuzzy logic systems and artificial neural networks. 2. Know how Artificial Neural Network techniques are applied to engineering problems, including control systems. 3. Understand Genetic Algorithm methods for solving control system problems. 4. Able to design control systems using fuzzy logic and artificial neural networks.	At the end of the course the student should be able to: 1. Explain the concept of intelligent control and Expert systems. 2. Classify the various ANN Models and train the network for control system specific application. 3. Design Fuzzy Logic Controller with Knowledge based rules and specification. 4. Develop applications using Genetic Algorithm, Fuzzy Logic, Neural Networks and able to Model Linear and Non Linear systems using Matlab.

UNIT I: INTRODUCTION **12**

Approaches to intelligent control. Architecture for intelligent control. Symbolic reasoning system, rule-based systems, the AI approach. Knowledge representation. Expert systems.

UNIT II: ARTIFICIAL NEURAL NETWORKS **12**

Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, simple perceptron, Adaline and Madaline, Feed-forward Multilayer Perceptron. Learning and Training the neural network. Data Processing: Scaling, Fourier transformation, principal-component analysis and wavelet transformations. Hopfield network, Self-organizing network and recurrent network. Neural Network based controller

UNIT III: GENETIC ALGORITHM **12**

Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other search techniques like tabu search and ant-colony search techniques for solving optimization problems.

UNIT IV: - FUZZY LOGIC SYSTEM **12**

Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modelling and control. Fuzzification, inference and defuzzification. Fuzzy knowledge and rule bases. Fuzzy modelling and control schemes for nonlinear systems. Self-organizing fuzzy logic control. Fuzzy logic control for nonlinear time-delay system.

UNIT V: - APPLICATIONS **12**

GA application to power system optimisation problem, Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab-Neural Network toolbox. Stability analysis of Neural-Network interconnection systems. Implementation of fuzzy logic controller using Matlab fuzzy-logic toolbox. Stability analysis of fuzzy control systems.

L = 45 T = 15 Total = 60

REFERENCE BOOK

1. Jacek.M.Zurada, "Introduction to Artificial Neural Systems", Jaico Publishing House, 1999.
2. Kosko, B. "Neural Networks and Fuzzy Systems", Prentice-Hall of India Pvt. Ltd., 1994.
3. Klir G.J. &Folger T.A. "Fuzzy sets, uncertainty and Information", Prentice-Hall of India Pvt Ltd., 1993
4. Zimmerman H.J. "Fuzzy set theory-and its Applications"-Kluwer Academic Publishers, 1994.
5. D. Driankov, H. Hellendoorn, M. Rein frank, "Introduction to Fuzzy Control", Narosa Publishers, 2001.

PIA203	**INDUSTRIAL AUTOMATION AND ROBOTICS**	4 CREDITS
Goal	To understand the concepts of automation and the requirement for automation in industries. They would also understand the basics of robotics and their real time applications.	

Objectives	**Outcome**
The course should enable the students to : 1. Understand concepts of Industrial Automation. 2. Understand basics of robotics. 3. Understand various Automation Techniques used in current scenario. 4. Understand the design and application of robots in various fields such as industry, defense, etc.	At the end of the course the student should be able to: 1. Explain the requirements of modern day industries. 2. Differentiate between high volume manufacturing automation and flexible manufacturing. 3. Design robots for industrial applications.

UNIT-I: - Introduction to Automation **12**

Automation production system, Mechanization and automation, Types of automation, Automation strategies, Mechanical, electrical, hydraulic and Pneumatic automation devices and controls, Economics of automation.

UNIT-II: - High Volume Manufacturing Automation **12**

Classification and type of automatic transfer machines; Automation in part handling and feeding, Analysis of automated flow lines, design of single model, multimodel and mixed model production lines.

Programmable Manufacturing Automation CNC machine tools, Machining centers, Programmable robots, Robot time estimation in manufacturing operations.

UNIT-III: - Flexible Manufacturing Automation **12**

Introduction to Group Technology, Grouping methods, Cell Design, Flexible manufacturing system. Assembly Automation: Assembly systems, Automatic transfer, feeding and orienting devices, Flexible assembly systems, Performance evaluation and economics of assembly systems.

UNIT- IV:- Robotics **12**

Review of robotic technology and applications, Laws of robotics, Robot systems and anatomy, Robot classification, End Effectors, Robot kinematics, Object location, Homogeneous transformation, Direct and inverse kinematics, Manipulator motions, Robot drives, actuators and control, Drive systems, Hydraulic, Pneumatic Electrical DC and AC servo motors and stepped motors, Mechanical transmission method-Rotary-to-rotary motion conversion, Robot motion and path planning control and Controllers, Robot sensing, Range sensing, Proximity sensing, touch sensing, Force and torque sensing etc., Robot vision, Image representation, Image recognition approaches.

UNIT- V:- Robot Applications **12**

Robot applications in manufacturing-Material transfer and machine loading/unloading, Processing operations like Welding & painting, Assembly operations, Inspection automation, Robot cell design and control, Robot cell layouts-Multiple robots & Machine interference, Economics and social aspects of robotics. Task Programming, Goals of AI Research, AI Techniques, Robot Intelligence and Task Planning, Modern Robots, Future Application and Challenges and Case Studies.

L = 45 T = 15 Total = 60

REFERENCE BOOK

1. Automation, Production System & Computer Integrated Manufacturing Groover Prentice Hall India
2. Principles of Automation & Automated Production Process Malov and Ivanov Mir Publication
3. Automation in Production Engineering Oates and Georgy Newness -
4. Stochastic Models of Manufacturing Systems Buzacott& shanty Kumar Prentice Hall India
5. Robotics K.S. Fu, R.C. Gonzalez, C.S.G. Lee McGraw Hill
6. Robotics J.J. Craig Addison-Wesely
7. Robot Engineering: AnIntegrated Approach R.D.Klafter, T.A.Chmielewski and M.Negin, Prentice Hall India.

PIA204	PROCESS DYNAMICS AND CONTROL	4 CREDITS
Goal	Students completing this course will understand the concepts of Process Modelling, Process Simulation, various analyses, and physiological models. Students will also have knowledge on Linear and Non Linear State space modelling and the basics of Process Control and Instrumentation.	
Objectives		Outcome

To impart knowledge on. 1. Fundamentals of Process Modeling, their design and operation. 2. Simulation, analysis and dynamics of reactors. 3. Physiological models and their modeling. 4. State space modeling of linear and nonlinear systems. 5. Process control and instrumentation.	At the end of this course students should have knowledge in the following. 1. Process modeling fundamentals. 2. Process simulation analysis. 3. Principal Component analysis. 4. Neural networks and fuzzy modeling. 5. Distillation columns and its control.

UNIT-I: - Introduction to Process Modeling **12**

Process Modeling Fundamentals, Extended Analysis of Modeling for Process Operation, Design for Process Modeling and Behavioral Models, Transformation Techniques, Linearization of Model Equations, Operating Points.

UNIT-II: - Process Simulation **12**

Frequency Response Analysis, General Process Behavior, Analysis of a Mixing Process, Dynamics of Chemical Stirred Tank Reactors, Dynamic Analysis of Tubular Reactors, Dynamic Analysis of Heat Exchangers, Dynamics of Evaporators and Separators, Dynamic Modeling of Distillation Columns, Dynamic Analysis of Fermentation Reactors.

UNIT-III: - **Introduction to Physiological Models** **12**

Modeling of Glucose and Insulin Levels, Introduction to Black Box Modeling, Basics of Linear Algebra, Data Conditioning, Principal Component Analysis, Partial Least Squares, Time-series Identification.

UNIT-IV: - Discrete Linear and Non-linear State Space Modeling **12**

Discrete Linear and Non-linear State Space Modeling, Model Reduction. Neural Networks, Fuzzy Modeling, Neuro Fuzzy Modeling, Hybrid Models.

UNIT-V: **-: Introduction to Process Control and Instrumentation** **12**

Behavior of Controlled Processes, Design of Control Schemes, Control of Distillation Columns, Control of a Fluid Catalytic Cracker

L = 45 T = 15 Total = 60

REFERENCE BOOK

1. Brian Roffel, Ben Betlem, "Process Dynamics and Control-Modeling for Control and Prediction"
2. B.W.Bequette, "Process Dynamics – Modeling, Analysis and Simulation", PHIPE, New Delhi.
3. G.Stephanapoulous, "Chemical process control: An introduction to Theory and Practice" Prentice Hall of India (P) Ltd., New Delhi, 1995.
4. F.G.Shinsky, "Process Control Systems, Application, Design and Adjustment" 3rd Edition, Mc.Graw Hill Book Co., New /York, 1988.

PIA211	EXPERT SYSTEMS LABORATORY	1 CREDIT
Goal	To equip students with skills in various packages like MATLAB, LABVIEW, etc. and to give exposure in PC based Digital control system techniques.	

Objectives	Outcome
To impart knowledge on. 1. MATLAB software basics. 2. Usage of Fuzzy Logic Toolbox in MATLAB. 3. Usage of Neural Network Toolbox in MATLAB.	At the end of this course students should have knowledge in the following. 1. Expertise in MATLAB software. 2. Design of fuzzy logic controller using Fuzzy Logic Toolbox in MATLAB. 3. Design a self-executable neural classifier using Neural Network Toolbox in MATLAB.

LIST OF EXPERIMENTS

The following experiments are to be tested using MATLAB toolboxes although Programming Language is suggested as a better option:

I. MATLAB Fuzzy Logic Toolbox

1. To implement fuzzy set operations
2. To implement fuzzy relational operations.
3. To design and implement fuzzy temperature controller
4. To design and implement Fuzzy Traffic light controller
5. To write and illustrate the concept of Fuzzy C – means Clustering
6. To design a self-executable fuzzy logic controller

II. MATLAB Neural Network Toolbox

7. Write programs to test the learning rules of Hebb, Perceptron, Delta, and Widrow Hoff in MATLAB learning rule.
8. To implement the Back propagation algorithm
9. To write and test a program for the linear separability of the input domain
10. To write and implement a Hopfield algorithm.
11. To write a program for pattern recognition
12. To design a self-executable neural classifier.

REFERENCE BOOK

1. JyhShing Roger Jang, Chuen-Tsai Sun, EijiMizutani - "Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning", Prentice Hall. 1997
2. Chin –Teng Lin and C.S. George Lee - "Neural Fuzzy Systems" – A Neuro fuzzy synergism to intelligent systems Prentice Hall International. 1996
3. Yanqing Zhang and Abraham Kandel - "Compensatory Genetic Fuzzy Neural Networks andTheir Applications" World Scientific. 1998
4. S.N. Sivanandam, S. Sumathi, S.N. Deepa Introduction to Neural Networks using Mat Lab6.0 – Tata Mc Graw Hill 2006.

P=45 TOTAL=45

PIA212	**INDUSTRIAL AUTOMATION AND ROBOTICS LABORATORY**	1 CREDIT
Goal	To equip students with skills in various packages like MATLAB, LABVIEW, etc. and to give exposure in PC based Digital control system techniques.	
Objectives	**Outcome**	

To impart knowledge on. 1. Data Loggers / Data Acquisition Systems. 2. Interfacing PC with Real-time systems. 3. Position control system. 4. Control of second-order plan using Micro controllers. 5. Temperature and Level control. 6. Programmable Logic Controllers forreal-time systems. 7. Modelling of physical systems	At the end of this course students should have knowledge in the following. 1. Application of Data Loggers / Data Acquisition Systems in Control Applications. 2. Interfacing a PC with Real-time systems Control. 3. Digital position control system. 4. Digital control of second-order plan using Micro controllers. 5. Digital temperature and level control. 6. Design of Programmable Logic Controllers for real-time systems. 7. Modelling of physical systems for electrical, hydraulic and pneumatic systems.

LIST OF EXPERIMENTS

1. Study of Data Loggers / Data Acquisition Systems.
2. Study of Interacting and Non Interacting System (Cascade and ratio controller implementation).
3. Interfacing PC with Real-time systems.
4. Digital position control system.
5. Digital control of second-order plant using Micro controllers.
6. Digital temperature and level control.
7. Design and analysis of second-order systems.
8. Design of Programmable Logic Controllers for real-time systems.
9. Modeling and analysis of basic hydraulic systems using MATLAB/LABVIEW software.
10. Modeling and analysis of basic electrical using MATLAB/LABVIEW software.
11. Modeling and analysis of basic pneumatic systems using MATLAB/LABVIEW software.

P=45 TOTAL=45

SEMESTER III
List of Electives
Elective-I

PIA321	**SCADA SYSTEMS AND APPLICATIONS**	**4 CREDITS**
Goal	By completing this course students will have a thorough understanding of SCADA, their System Components, and various SCADA Architectures. Students will also acquire knowledge on various applications of SCADA in real time and the basics of Programmable Automation Controllers. (PAC)	
Objectives	**Outcome**	

To impart knowledge on. 1. Basics of Data acquisition systems and evolution of SCADA. 2. SCADA System Components. 3. Various SCADA architectures, their advantages and disadvantages. 4. SCADA Applications. 5. Programmable Automation Controllers.	At the end of this course students should have knowledge in the following. 1. Evolution of SCADA and their need in utility automation and industries. 2. Analysis of the various SCADA System Components. 3. SCADA architectures, SCADA Communication technologies. 4. Practice in simulation exercises to understand the applications of SCADA. 5. OLE for Process Control, PAC and its architecture using NI hardware and software.

Unit I Introduction to SCADA **9**

Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries

Unit II: SCADA System Components **9**

Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems

Unit III: SCADA Architecture **9**

Various SCADA architectures, advantages and disadvantages of each system - single unified standard architecture -IEC 61850 SCADA Communication: various industrial communication technologies -wired and wireless methods and fiber optics. Open standard communication protocols

Unit IV: SCADA Applications **9**

Utility applications- Transmission and Distribution sector -operations, monitoring, analysis and improvement. Industries - oil, gas and water. Case studies, Implementation, Simulation Exercises

Unit V: OLE for Process Control& PAC **9**

OPC Basics, OPC Standards, Introduction to Programmable Automation Controllers (PAC), PAC architecture using NI hardware and software

L=45 , T 15 TOTAL=60

REFERENCE BOOK

1. Stuart A. Boyer: SCADA-Supervisory Control and Data Acquisition, Instrument Society of America Publications, USA, 2004.
2. Gordon Clarke, Deon Reynders: Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems, Newnes Publications, Oxford, UK,2004
3. William T. Shaw, Cybersecurity for SCADA systems, Penn Well Books, 2006
4. David Bailey, Edwin Wright, Practical SCADA for industry, Newnes, 2003
5. Michael Wiebe, A guide to utility automation: AMR, SCADA, and IT systems for electric power.

PIA322	DATA ACQUISITION SYSTEMS	4 CREDITS
Goal	After completing this course, students will understand the objective of a Data Acquisition System, its types, characteristics, and its principles. Students will also be able to differentiate between linear and non-linear data converters and its applications.	

Objectives	Outcome
To impart knowledge on. 1. Single channel and multi-channel DAS and its components, characteristics. 2. Digital to analog converters (DACS) and Analog to Digital Converters (ADCS), their classification. 3. Non- linear data converters (NDC), its configurationand applications. 4. ADC Applications. 5. Monolithic data converters.	At the end of this course students should have knowledge in the following. 1. Converters and its types, principles, coding and decoding. 2. Configuration of NDC and data converter applications. 3. Various industrial applications of ADC. 4. Interfacing of DACS and ADCS to a µP. 5. Error budget of DACS and ADC'S

UNIT-I **9**

INTRODUCTION: Objective of a DAS, single channel DAS, Multi-channel DAS,Components used in DAS– Converter Characteristics-Resolution-Non-linearity,settling time, Monotonicity.

DIGITAL TO ANALOG CONVERTERS (DACS): Principles and design of – Parallel R– 2R, Weighted resistor, inverted ladder, D/A decoding – Codes other than ordinary binary.

UNIT-II **9**

ANALOG TO DIGITAL CONVERTERS (ADCS): Classification of A/D converters. Parallel feedback – Successive approximation – Ramp comparison – Dual slope integration – Voltage to frequency – Voltage to Time – Logarithmic types of ADCS.

UNIT-III **9**

NON-LINEAR DATA CONVERTERS (NDC): Basic NDC configurations – Some common NDACS and NADCS – Programmable non-linear ADCS – NADC using optimal sized ROM – High speed hybrid NADC – PLS based NADC – Switched capacitor NDCS.

DATA CONVERTER APPLICATIONS: DAC applications – Digitally programmable V/I sources – Arbitrary waveform generators – Digitally programmable gain amplifiers – Analog multipliers/ dividers – Analog delay lines.

UNIT-IV **9**

ADC APPLICATIONS: Data Acquisition systems – Digital signal processing systems – PCM voice communication systems – Test and measurement instruments – Electronic weighing machines.

UNIT-V **9**

MONOLITHIC DATA CONVERTERS: typical study of monolithic DACS and ADCS. Interfacing of DACS and ADCS to a microprocessor

Error budget of DACS and ADCS: Error sources, error reduction and noise reduction techniques in DAS. Error budget analysis of DAS, case study of a DAC and an ADC.

L=45 , T 15 TOTAL=60

REFERENCE BOOK

1. Electronic data converters fundamentals and applications – Dinesh K. Anvekar, B.S. Sonde – Tata McGraw Hill.

2. Electronic Analog/ Digital conversions – Hermann Schmid – Tata McGraw Hill.E.R. Hanateck, User's Handbook of D/A and A/D converters – Wiley
3. Electronic instrumentation by HS Kalsi- TMH 2 nd Edition, 2004.
4. Data converters by G.B. Clayton.

PIA323	ADVANCED SENSOR TECHNOLOGY	4 CREDITS
Goal	After completing this course students will understand about various sensors and their applications in industry. Students will also be able to design various sensor circuits for industries.	

Objectives	Outcome
To impart knowledge on. 1. Chemical sensors and its types. 2. Optical sensors and its types. 3. Biomedical sensors, types and its applications like ECG, EEG etc. 4. Advanced Sensor design. 5. Aerospace Sensor and its applications.	At the end of this course students should have knowledge in the following. 1. Chemical Sensors. 2. Fiber optic light propagation in Optical Sensors. 3. Sensors used in human body, Bioelectric Amplifiers. 4. Various Electrodes, ECG, EEG, electrodes ECG signals, waveforms. 5. Sensor designing, Fluoroscopic Machines Design.

Unit-I **9**

Chemical Sensors: Blood –Gas and Acid –base physiology of electrochemical sensors, Chemical Fibro sensors, Iron-Selective Field-Effect Transistor (ISFET), Immunologically Sensitive Field Effect Transistor (IMFET), integrated flow sensor and Blood Glucose sensors.

Unit-II **9**

Optical Sensors: Fiber optic light propagation, Graded index fibers, Fiber optic communication Driver circuits, Laser classifications, Driver circuits for solid –state laser diodes, Radiation sensors and Optical combinations.

Unit-III **9**

Biomedical Sensors: Sensors Terminology in human body, Introduction, Cell, Body Fluids Musculoskeletal system, Bioelectric Amplifiers, Bioelectric Amplifiers for Multiple Input Circuits, Differential Amplifiers, Physiological Pressure and other cardiovascular Measurements and devices.

Electrodes: –Electrodes for Biophysical sensing, Electrode model circuits, Microelectrodes, ECG, EEG, electrodes ECG signals, waveforms, Standard lead system, Polarization, Polarizable, Non polarizable electrodes and body surface recording electrodes. Ultrasonic Transducers for Measurement and therapy – radiation detectors – NIR spectroscopy.

Unit-IV **9**

Advanced Sensor Design: Fluoroscopic machines design, Nuclear medical systems, EMI to Biomedical sensors, types and sources of EMI, Fields, EMI effects. Computer systems used in X ray and Nuclear Medical Equipments. Calibration, Typical faults, Trouble shooting, Maintenance Procedure for medical equipment's and Design of 2& 4 wire transmitters with 4 – 20 mA output.

Unit-V **9**

Aerospace Sensor: Gyroscope laser and accelerometers. Sensors used in space and environmental applications.

L=45 , T 15 TOTAL=60

REFERENCE BOOK

1. Sensors Hand Book Sabaree Soloman - Sensors Hand Book, McGraw Hill, 1998
2. Smith H.M. - Principles of Holography, John Wiley & Sons, New York, 1975
3. J.G. Webster Medical instrumentation Application and Design, Houghton Mifilin Co. 2004,
4. Carr and Brown - Introduction to Medical Equipment Technology, Addison Wesley. 1999

5. Culshaw B and Dakin J (Eds) Optical Fibre Sensors, Vol. 1 & 2 Artech House, Norwood.(1989)
P. Garnell– Guided Weapon Control Systems – Pergamon Press. 1980.

Elective-II

PIA324	SYSTEM IDENTIFICATION AND CONTROL	4 CREDITS
Prerequisite	Linear and Non linear System Theory	
Goal	To impart knowledge about system identification techniques and controlling process.	

Objectives	Outcome
The course will enable the students to : 1. Gain basic knowledge in Process Dynamics 2. Learn about various control strategies for Process plant. 3. Understand the various methods used for Process Identification 4. Learn the various techniques used for process activation. 5. Setup virtual control system environment	The students should be able to: 1. Derive mathematical Model of the Systems. 2. Implement Controllers for Various control systems. 3. Identify the systems of various continuous and discrete process 4. Implement various process activation techniques for process 5. Realize and deploy virtual control system

Unit I: **9**

Basics of Process Dynamics: - Mathematical Representations of Linear Processes, Simulations, Dynamic Behavior of Linear Processes

Unit II: **9**

Process Control: - Proportional–Integral–Derivative Control, Proportional–Integral–Derivative Controller Tuning, Dynamic Behavior of Closed-Loop Control Systems, Enhanced Control Strategies- Cascade Control- Time-Delay Compensators- Gain Scheduling-Proportional–Integral–Derivative Control using Internal Feedback Loop.

Unit III: **9**

Process Identification:- Process Identification Methods for Frequency Response Models, Process Identification Methods for Continuous-Time Differential Equation Models, Process Identification Methods for Discrete-Time Difference Equation Models, Model Conversion from Discrete-Time to Continuous-Time Linear Models.

Unit IV: **9**

Process Activation: - Relay Feedback Methods- Conventional Relay Feedback Methods- Relay Feedback Method to Reject Static Disturbances-Relay Feedback Method under Nonlinearity and Static Disturbances-Relay Feedback Method for a Large Range of Operation Problems, Modifications of Relay Feedback Methods- Process Activation Method Using Pulse Signals-Process Activation Method Using Sine Signals Problem.

Unit V: **9**

Virtual Control System: - Setup of the Virtual Control System, Case studies

L=45 , T 15 TOTAL=60

REFERENCE BOOK

1. Su Whan Sung, Jietae Lee, In-Beum Lee- Process Identification and PID Control-Jhon Wiley and sons.

2. Banks J, Carson J.S and Nelson B Discrete Event system Simulation, (2e) prentice hall, 1996.
3. Edwards D and Hamson M Guide to mathematical Modelling, Macmillan, London-1989.
4. Giordano F.R and Weir MDA first course in mathematical modeling, Wadsworth-1985.
5. Deo N System's simulation with digital compute Prentice Hall-1983.

PIA325	MULTI-VARIABLE CONTROL	4CREDITS
Goal	To provide basic knowledge about various Controllers, Observers and Solutions to their objective Problems	

Objectives	Outcome
The course will enable the students : 1. To impart knowledge about the various process variables, types of models and its equivalence. 2.Emphasis on Linear Systems, Its Time Response, Frequency Response and Stability Conditions. 3. To acquire knowledge in decentralised and decoupled Control. 4. To acquaint them with various Controllers and Observers and their modelling with solutions to their objective problems.	The students should be able to: 1. Understand the basic principles of Models and its Representations. 2. Analyse the Linear Systems and Discretization Techniques. 3. Understand the various types of decentralised and decoupled control 4. Design an optimal State Feedback Controller, Kalman observer and understand Optimisation based Control.

UNIT-I: - LINEAR SYSTEM REPRESENTATION: MODELS AND EQUIVALENCE 9

Introduction, Process Instrumentation, Process Variables, Types of Models, Input/output Representations, Systems and Subsystems: Interconnection, Equivalence of Representations, Key issues in Modeling

UNIT-II: - LINEAR SYSTEM ANALYSIS 9

Introduction, Linear-System Time Response, Stability Conditions, Discretization, Gain, Frequency Response, System internal Structure, Block System Structure: Kalman Form, Input/output Properties, Model Reduction, key issues in MIMO Systems Analysis

UNIT-III: - SOLUTIONS TO THE CONTROL PROBLEM 9

The Control Design Problem, Control Goals, Variables Selection, Control Structures, Feedback Control, Closed-loop stability analysis, Feed forward control, Two degree of freedom controller, hierarchical control, key issues in control design

UNIT-IV: - DECENTRALISED AND DECOUPLED CONTROL 9

Introduction, multi-loop control, Pairing Selection, The Relative Gain Array Methodology, Decoupling, Enhancing SISO Loops with MIMO Techniques: Cascade Control, Other possibilities, Sequential-Hierarchical Design and Tuning

UNIT-V: - OPTIMISATION BASED CONTROL 9

Optimal State Feedback, Kalman Observer, Linear Quadratic Gaussian Control, Predictive Control, Distribution Rejection, A Generalized Optimal Disturbance-rejection Problem, Distillation Column: Case Study

L=45 , T 15 TOTAL=60

REFERENCE BOOK

1. Multivariable Control Systems: An Engineering Approach by P. Albertos, A. Sal, Springer-Verlag London Limited, 2004
2. Multivariable Feedback design by Maciejowski J.M., published by Adison-Wesley
3. Multivariable Feedback Control by Sigurd Stogestad and Ian Postletwaite, published by Wiely.

4. Control Configuration Selection in Multivariable Plants by A. Khaki-Sedigh, B. Moaveni, published by Springer Verlag, 2009.

PIA326	FAULT DETECTION AND DIAGNOSIS	4 CREDITS
Prerequisite	Linear and Non-linear System Theory	
Goal	To impart basic knowledge in fault detection and diagnosis in process plant	

Objectives	Outcome
The course will enable the students to : 1. Gain basic knowledge about faults and diagnosis occurring in process plants 2. Know the various methods used for system identification 3. Understand the Pattern recognition methods for fault diagnosis. 4. Realize Fault diagnosis advanced techniques based on process state estimation 5. Work on Artificial neural networks for fault diagnosis	The students should be able to: 1. Analyze faults and diagnosis occurring in process plants. 2. Identify systems based on various methods. 3. Develop and implement Pattern recognition methods for fault diagnosis. 4. Analyze Fault and diagnose themusing advanced techniques based on process state estimation 5. Implement Artificial neural networks for fault diagnosis

Unit I: - Basic concepts: - **9**

The concept of system analysis -- Basic concepts in fault diagnosis --Fault diagnosis methods classification ---Elementary functions and performance criteria for the fault diagnosis systems -- Fault diagnosis based on process parameters: Problem formulation -Usual parametric methods -- Relations between process parameters and model parameters

Unit II. Continuous-time system identification methods **9**

Problem formulation --State-space variables filtering method --Poisson function moments method -- Piece-wise orthogonal function (Walsh) method --Usual numerical techniques: leas-squares method and total least-squares method (on- and off-line variants)

Unit III. Pattern recognition methods for fault diagnosis. **9**

Basic concepts in pattern recognition --Fundamental principles of the statistic pattern recognition -- Clustering and pattern recognition nonparametric techniques --Particularities of the pattern recognition -- principles applied to fault diagnosis Fault diagnosis based on process state estimation-- fundamental principles. The main concept of the fault detection and isolation based on state estimators (observers) -Linear observers for fault diagnosis: complete order observers, reduced order -- observers, sensor and -- component fault detection observer schemes -- Nonlinear observers for fault diagnosis

Unit IV. Fault diagnosis advanced techniques based on process state estimation **9**

Unknown inputs robust fault diagnosis –linear systems case --Observers for robust fault diagnosis Observers for robust fault diagnosis design: observable canonical form, the robust observer design based on the observable canonical form, optimal robust observers design

Unit V Artificial neural networks for fault diagnosis. **9**

Basic concepts on Artificial Neural Networks (ANN) ANN architectures: Multi-Layer Perceptron, Radial-Basis Functions Networks --ANN training: back-propagation algorithm, orthogonal least-

squares algorithm --Fault diagnosis using ANNs: ANNs used for symptom generation, ANNs used for symptom evaluation.

L=45 , T 15 TOTAL=60

REFERENCE BOOK

1. Isermann, R., (2006), Fault-Diagnosis Systems, Springer-Verlag, Berlin.
2. Chen,J. and R.J.Patton, (1999), Robust Model-based Fault Diagnosis for Dynamic Systems, Kluwer Academic Publ., Boston.
3. R.J.Patton, P.M.Frank, R.N.Clark (Eds), (2000), Issues in Fault Diagnosis for Dynamic Systems, Springer-Verlag, New York.
4. Blanke, M., M. Kinnaert, J. Lunze, M. Staroswiecki, (2006), Diagnosis and Fault Tolerant Control, Springer-Verlag, Berlin.

Elective-III

PIA327	COMPUTER CONTROL OF MANUFACTURING SYSTEMS	4 CREDITS
Goal	To acquaint the students with concepts in manufacturing systems	

Objectives	Outcome
The course should enable the students to: 1. Gain basic concepts in manufacturing systems 2. Understand control loops and adaptive schemes for NC machines 3. Acquaint concepts and digitization of CNC 4. Gain knowledge about CIM 5. Know the basics of Flexible manufacturing systems	At the end of the course the student should be able to: 1. Analyse manufacturing systems and their functionality. 2. Realize various control loops and adaptive schemes related NC machines 3. Acquire and analyze systems of CNC 4. Analyze CIM and its data related systems 5. Deploy and verification of functionality of Flexible manufacturing systems

Unit I: -Basic concepts in Manufacturing Systems **9**

Introduction Basic concepts in Manufacturing Systems, Fundamentals of Numerical Control, Advantages of NC systems, Classification of NC Systems. Interpolators for manufacturing systems DDA Integrator, DDA Hardware Interpolator, CNC software Interpolators, Reference word CNC interpolators, the concept of reference word interpolators. Tusten Method.

Unit II: -Control Loops of NC Systems: **9**

Introduction, Control of Point-to-point Systems, Control loops in Contouring Systems, Mathematical Analysis and operation of a two axis system. Adaptive Control Systems: Introduction, Adaptive control with optimization, Adaptive control with Constraints. ACC for turning, Variable Gain AC systems Adaptive control for grinding, Cost analysis in machining.

Unit III: - Manufacturing system simulation: **9**

Introduction, Types of simulation, Need and elements of simulation, Simulation methodology. Computerized Numerical Control: CNC Concepts, Advantages, The Digital Computer, Reference Pulse Technique, Sampled-Data Technique, Design Principles, Optimization for Circular Motion, summary of design considerations, micro computers in CNC.

Unit IV: -Computer integrated Manufacturing systems **9**

Computer integrated Manufacturing systems Introduction, Modern manufacturing, Sequence of Functions in CIM, Elements of CIM system, CIM data base management system, CIM related standards, Guide lines for CIM development Benefits of CIM.

Unit V: -Flexible manufacturing systems **9**

Flexible manufacturing systems Introduction, Elements of FMS, Classification and Types of FMS, FMS work stations, Lay out configurations, Petrinets , modeling with Pertinets.

L=45 , T 15 TOTAL=60

REFERENCE BOOK

1. Computer control of manufacturing systems - YoremKoren, Tata McGraw-Hill edition, 2005.
2. Computer Aided Design and Manufacturing - Dr.Sadhusingh, Khanna Publishers, 2002
3. Simulation modeling and Analysis - Averill M Law, TMH, 2008.

PIA328	MECHATRONICS IN MANUFACTURING SYSTEMS	4 CREDITS
Goal	To impart knowledge in the inter disciplinary field of Mechatronics as related to Manufacturing.	

Objectives	Outcome
The course should enable the student to 1. Gain basic knowledge in Mechatronic systems. 2. Know the various types of sensors and selection procedures. 3. Learn about the types of actuators used in Mechatronic systems. 4. Understand the operation of Programmable Logic Controllers. 5. Have an idea mechatronic systems applied in practical situation.	The students should be able to: 1. Develop an interdisciplinary understanding and integrated approach to engineering. 2. Select sensor for various applications 3. Acquaint themselves with actuators used in Mechatronic systems. 4. Deploy Programmable Logic Controllers for various applications. 5. Understand the real time applications and Develope them.

UNIT I INTRODUCTION **6**

Introduction to Mechatronics - Systems- Need for Mechatronics - Emerging area of Mechatronics - Classification of Mechatronics - Measurement Systems – Control Systems.

UNIT II SENSORS AND TRANSDUCERS **9**

Introduction - Performance Terminology – Potentiometers - LVDT – Capacitance sensors - Strain gauges - Eddy current sensor - Hall Effect sensor – Temperature sensors - Light sensors - Selection of sensors - Signal processing.

UNIT III ACTUATORS **12**

Actuators – Mechanical - Electrical - Fluid Power - Piezoelectric – Magnetostrictive - Shape memory alloy - applications - selection of actuators.

UNIT IV PROGRAMMABLE LOGIC CONTROLLERS **9**

Introduction - Basic structure - Input and output processing - Programming -Mnemonics- Timers, counters and internal relays - Data handling - Selection of PLC.

UNIT V DESIGN AND MECHATRONICS CASE STUDIES **9**

Designing - Possible design solutions-Traditional and Mechatronics design concepts- Case studies of Mechatronics systems - Pick and place Robot - Conveyor based material handling system - PC based CNC drilling machine – Mechatronics Control in automated Manufacturing – Data Acquisition Case studies.

L=45 , T 15 TOTAL=60

REFERENCE BOOK

1. Bolton.W, “Mechatronics”, Pearson education, second edition, fifth Indian Reprint, 2003
2. Smaili.A and Mrad.F, "Mechatronics integrated technologies for intelligent machines", Oxford university press, 2008.

3. Devadas Shetty and Richard A.Kolk, “Mechatronics systems design”, PWS Publishing Company, 2007.
4. Godfrey C. Onwubolu, "Mechatronics Principles and Applications", Elsevier, 2006.
5. NitaigourPremchandMahalik, “Mechatronics Principles, Concepts and applications” Tata McGraw-Hill Publishing Company Limited, 2003.
6. Michael B.Histand and Davis G.Alciatore,”Introduction to Mechatronics and Measurement systems”. McGraw Hill International edition, 1999.
7. Bradley D.A, Dawson.D, Buru N.C and Loader A.J, “Mechatronics” Nelson Thornes Ltd, Eswar press, Indian print, 2004.

PIA329	**PROCESS CONSULTING AND PROJECT PLANNING**	**4 CREDITS**
Goal	To expose the students to the basic processing, measurement techniques and control systems in petroleum industry and to provide adequate knowledge about the petroleum products and the chemicals obtained from them.	

Objectives	**Outcome**
The course will enable the students to : 1. Develop the knowledge in the direction of cumulative project engineering. 2. Gather all knowledge required in project planning, execution and monitoring. 3. Acquaint them with documentation in process engineering. 4. Gain skills in procurement and functional verification of process Systems. 5. Gather knowledge about management functions and tools used for doing it.	After completion of the course the students are expected to be able to: 1. Develop and deploy the cumulative engineering projects. 2. Understand and accomplish project planning, execution and monitoring. 3. Complete the documentation work for projects. 4. Develop interpersonal skills in procurement and functional verification of process Systems. 5. Use Management tools for various management related function of a project.

UNIT- I: - Introduction **9**

Definition of project, purpose, scope, time, quality and organization structure. Basic and detailed engineering: Degree of automation, Project S curves, manpower considerations, inter-department and inter organization interactions, Multi agency interaction. Types of projects and types of contracts e.g. EPC, BOOT etc.

UNIT-II: -Project Pre-planning steps **9**

Role of Automation, Customer expectations and performance criterion, User Requirement Specifications (URS), Functional Design Specifications (FDS), Software Requirement Specifications and Hardware Requirement Specifications (SRS and HRS), International Standards and Practices, Consultant Requirements. Project execution steps. Instrumentation Audit, Plant layout, general arrangement drawing (plans and elevations). Selection criterion for equipment at different levels of automation.

UNIT- III Project Documentation **9**

Design Engineering, documentation, Process function diagrams and interlock, interface diagrams, Process flow diagrams, P&ID, specification sheets, loop wiring diagrams, ladder diagrams, isometrics, installation detail drawing, Control console, centers and panels: Types, design, inspection and specification. Control panel drawings, Document control, Checklists, legend sheets, instrument catalogues, test and progress reports, and minutes of the meeting. Documentation software to create modifies, add, revise and update I&C documentation. Documents and version control Cable

engineering, different classes of conductors and their routines, types and specifications of cables, cable schedule, routing of cables.

UNIT- IV: -Procurement activities **9**

Vendor registration, tendering and bidding process, bid evaluation, purchase orders, vendor documents, drawings and reports as necessary at above activities. Construction activities: Site conditions and planning, front availability, installation and commissioning activities and documents require/generated at this stage. Factory Acceptance Test (FAT), On-site inspection and testing (SAT) installation sketches, bill of material, Quantity surveying, contracting, cold commissioning and hot Commissioning, CAT (Customer Acceptance Test), performance trials and final hand-over.

UNIT -V: - Project management: Management functions **9**

Controlling, directing, project authority, responsibility, accountability, interpersonal influences and standard communication formats, project reviews. Project planning and scheduling, life cycle phases, the statement of work (SOW), projects specifications, bar charts, milestones, schedules, work breakdown structures, cost breakdown structures and planning cycle. Cost and estimation: Types and estimates, pricing process, salary and other overheads, man-hours, materials and support costs. Program evaluation and review techniques (PERT) and critical path method (CPM), estimating activity time and total program time, total PERT/CPM planning crash times, software's used in project management.

L=45 , T 15 TOTAL=60

REFERENCE BOOK

1. Applied instrumentation in process industries Andrew and Williams Gulf publishing
2. Instrumentation Engineers Handbook: Process Control B. G. Liptak Chilton Book Company
3. Project management: A systems approach to planning Scheduling and Controlling HarlodKerzner Van Nostrand Reinhold publishing
4. Management systems John Bacon ISA
5. Batch control systems T.G.Fisher ISA
6. Instrument installation project management Reference Set,ISA.

PIA330 ADVANCED ADAPTIVE CONTROL SYSTEMS 4 Credits

GOAL: - To get fundamental idea on advanced Adaptive Control Systems

OBJECTIVES

- To introduce various model structures for system identification
- To impart knowledge on parametric and non-parametric identification
- To introduce non-linear identification techniques
- To introduce the concept of adaptation techniques and control
- To illustrate the identification and adaptive control techniques through case Studies

OUTCOMES

- To get knowledge about different models
- Able to design parametric and non-parametric models
- To get idea of non-linear techniques
- Will be able design different adaptation control techniques
- Will be able to apply adaptive control techniques through case studies

UNIT I MODELS FOR INDENTIFICATION 9

Models of LTI systems: Linear Models-State space Models-OE model- Model sets, Structures and Identifiability- Models for Time-varying and Non-linear systems: Models with Nonlinearities – Non-linear state-space models-Black box models, Fuzzy models'.

UNIT II NON-PARAMETRIC AND PARAMETRIC IDENTIFICATON 9

Transient response and Correlation Analysis – Frequency response analysis – Spectral Analysis – Least Square – Recursive Least Square –Forgetting factor- Maximum Likelihood – Instrumental Variable methods.

UNIT III NON-LINEAR IDENTIFICATION 9

Open and closed loop identification: Approaches – Direct and indirect identification –Joint input-output identification – Non-linear system identification – Wiener models –Power series expansions - State estimation techniques – Non-linear identification using Neural Network and Fuzzy Logic.

UNIT IV ADAPTIVE COTROL AND ADAPTATION TECHNIQUES 9

Introduction – Uses – Auto tuning – Self Tuning Regulators (STR) – Model Reference Adaptive Control (MRAC) – Types of STR and MRAC – Different approaches to self-tuning regulators – Stochastic Adaptive control – Gain Scheduling.

UNIT V CASE STUDIES 9

Inverted Pendulum, Robot arm, process control application: heat exchanger, Distillation column, application to power system, Ship steering control.

L=45 , T 15 TOTAL=60

REFERENCES

1. Ljung," System Identification Theory for the User", PHI, 1987.
2. Torsten Soderstrom, Petre Stoica, "System Identification", prentice Hall International (UK) Ltd, 1989.
3. Astrom and Wittenmark," Adaptive Control", PHI
4. William S. Levine, "Control Hand Book". Narendra and Annasamy," Stable Adaptive Control Systems, Prentice Hall, 1989.

PIA305	Project Phase-I	6 CREDITS
Goal	To enable the students to successfully initiate to implement the design and integrate various components and circuits that they have learned throughout their course work	
Objectives	Outcome	

The course will enable the students to: (i) Build circuits for the design considerations (ii) Develop a PC or Microprocessor based system design (iii) Troubleshoot and diagnose various faults occurring the circuits and software integration	After completion of the course the students are expected to be able to: (i) Design circuits for given specification (ii) Integrate various sensors and final control elements to a controller and perform necessary control actions (iii) Troubleshoot electronic circuit or software program

Guidelines & Evaluation Scheme

- Each of the students has to undertake a Project under the supervision of a teacher (max 4 students / batch) and to submit the same following the guidelines stated below.
- Language of Project Report and Viva-Voce Examination may be English
- Failure to submit the Project Report or failure to appear at the Viva-voce Examination will be treated as "Absent" in the Examination. He /she has to submit the Project Report and appear at the Viva-Voce Examination in the subsequent years (within the time period as per University Rules).
- No marks will be allotted on the Project Report unless a candidate appears at the Viva-Voce Examination. Similarly, no marks will be allotted on Viva-Voce Examination unless a candidate submits his/her Project Report.
- Evaluation of the Project Work to be done jointly by one internal expert and one external expert with equal weightage, i.e., average marks of the internal and external experts will be allotted to the candidate.
- A candidate has to qualify in the Project Work separately, obtaining a minimum marks of 50 (Project Report and Viva-Voce taken together).
- Marking Scheme for Project Report and Viva-Voce Examination:

Project Report (50 marks)

Chapter 1: Introduction – 10 marks
Chapter 2: Conceptual Framework/ National/International Scenario – 5 marks
Chapter 3: Presentation, Analysis & Findings -- 25 marks
Chapter 4: Conclusion & Recommendations -- 10 marks

Viva-Voce (50 marks)

In course of Viva-Voce Examination, the question may be asked in the following areas:

Importance / relevance of the Study, Objective of the Study, Methodology of the Study / Mode of Enquiry -- 15 marks
Ability to explain the analysis, findings, concluding observations, recommendation, limitations of the Study -- 25 marks
Overall Impression (including Communication Skill) -- 10 marks

THE COMPONENTS OF A PROJECT REPORT

The outcome of Project Work is the Project Report. A project report should have the following components:
1) Cover Page: This should contain the title of the project proposal, to whom it is submitted, for which degree, the name of the author, name of the supervisor, year of submission of the project work, name of the University.

2) Acknowledgement: Various organizations and individuals who might have provided assistance /co-operation during the process of carrying out the study.

3) Table of Content: Page-wise listing of the main contents in the report, i.e., different Chapters and its main Sections along with their page numbers.

4) **Body of the Report:** The body of the report should have these four logical divisions
a) ***Introduction:*** This will cover the background, rationale/ need / justification, brief review of literature, objectives, methodology (the area of the study, sample, type of study, tools for data collection, and method of analysis), Limitations of the Study, and Chapter Planning.
b) ***Conceptual Framework / National and International Scenario*****:** (relating to the topic of the Project).
c***) Presentation of Data,Analysis and Findings*****:**(using the tools and techniques mentioned in the methodology).
d) ***Conclusion and Recommendations:*** In this section, the concluding observations based on the main findings and suggestions are to be provided.

5) Bibliography or References: This section will include the list of books and articles which have been used in the project work, and in writing a project report.

6) Annexures: Questionnaires (if any), relevant reports, etc.
(The main text of the Project should normally be in the range of 5000 words. However, there may be annexure in addition to the main text)

SEMESTER IV

PIA406	**Project Phase-II**	**12 CREDITS**
Goal	To enable the students to successfully design and integrate various components and circuits that they have learned throughout their course work	
Objectives		**Outcome**
The course will enable the students to: (iv) Build circuits for the design considerations (v) Develop a PC or Microprocessor based system design (vi) Troubleshoot and diagnose various faults occurring the circuits and software integration		After completion of the course the students are expected to be able to: (iv) Design circuits for given specification (v) Integrate various sensors and final control elements to a controller and perform necessary control actions (vi) Troubleshoot electronic circuit or software program

Guidelines & Evaluation Scheme

- Each of the students has to undertake a Project under the supervision of a teacher (max 4 students / batch) and to submit the same following the guidelines stated below.
- Language of Project Report and Viva-Voce Examination may be English
- Failure to submit the Project Report or failure to appear at the Viva-voce Examination will be treated as "Absent" in the Examination. He /she has to submit the Project Report and appear at the Viva-Voce Examination in the subsequent years (within the time period as per University Rules).

- No marks will be allotted on the Project Report unless a candidate appears at the Viva-Voce Examination. Similarly, no marks will be allotted on Viva-Voce Examination unless a candidate submits his/her Project Report.
- Evaluation of the Project Work to be done jointly by one internal expert and one external expert with equal weightage, i.e., average marks of the internal and external experts will be allotted to the candidate.
- A candidate has to qualify in the Project Work separately, obtaining a minimum marks of 50 (Project Report and Viva-Voce taken together).
- Marking Scheme for Project Report and Viva-Voce Examination:

Project Report (50 marks)

Chapter 1: Introduction – 10 marks
Chapter 2: Conceptual Framework/ National/International Scenario – 5 marks
Chapter 3: Presentation, Analysis & Findings -- 25 marks
Chapter 4: Conclusion & Recommendations -- 10 marks

Viva-Voce (50 marks)

In course of Viva-Voce Examination, the question may be asked in the following areas:

Importance / relevance of the Study, Objective of the Study, Methodology of the Study / Mode of Enquiry -- 15 marks
Ability to explain the analysis, findings, concluding observations, recommendation, limitations of the Study -- 25 marks
Overall Impression (including Communication Skill) -- 10 marks

THE COMPONENTS OF A PROJECT REPORT

The outcome of Project Work is the Project Report. A project report should have the following components:
1) Cover Page: This should contain the title of the project proposal, to whom it is submitted, for which degree, the name of the author, name of the supervisor, year of submission of the project work, name of the University.

2) Acknowledgement: Various organizations and individuals who might have provided assistance /co-operation during the process of carrying out the study.

3) Table of Content: Page-wise listing of the main contents in the report, i.e., different Chapters and its main Sections along with their page numbers.

4) **Body of the Report:** The body of the report should have these four logical divisions
a) ***Introduction:*** This will cover the background, rationale/ need / justification, brief review of literature, objectives, methodology (the area of the study, sample, type of study, tools for data collection, and method of analysis), Limitations of the Study, and Chapter Planning.
b) ***Conceptual Framework / National and International Scenario*****:** (relating to the topic of the Project).
c***) Presentation of Data,Analysis and Findings*****:**(using the tools and techniques mentioned in the methodology).
d) ***Conclusion and Recommendations:*** In this section, the concluding observations based on the main findings and suggestions are to be provided.

5) Bibliography or References: This section will include the list of books and articles which have been used in the project work, and in writing a project report.

6) Annexures: Questionnaires (if any), relevant reports, etc.

(The main text of the Project should normally be in the range of 5000 words. However, there may be annexure in addition to the main text)