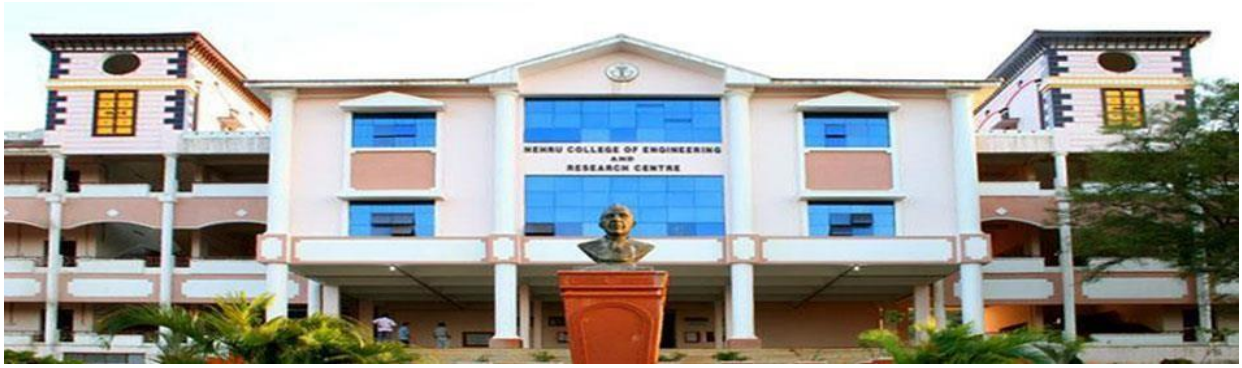
NEHRU COLLEGE OF ENGINEERING AND RESEARCH CENTRE

(Accredited by NAAC, Approved by AICTE New Delhi, Affiliated to APJKTU)

Pampady, Thiruvilwamala(PO), Thrissur(DT), Kerala 680 588

DEPARTMENT OF MECHATRONICS

SYLLABUS BOOK FOR STUDENTS



APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY 2015 SCHEME SYLLABUS FOR MECHATRONICS

VISION OF THE INSTITUTION

To mould our youngsters into Millennium Leaders not only in Technological and Scientific Fields but also to nurture and strengthen the innate goodness and human nature in them, to equip them to face the future challenges in technological break troughs and information explosions and deliver the bounties of frontier knowledge for the benefit of humankind in general and the down-trodden and underprivileged in particular as envisaged by our great Prime Minister Pandit Jawaharlal Nehru

MISSION OF THE INSTITUTION

To build a strong Centre of Excellence in Learning and Research in Engineering and Frontier Technology, to facilitate students to learn and imbibe discipline, culture and spirituality, besides encouraging them to assimilate the latest technological knowhow and to render a helping hand to the under privileged, thereby acquiring happiness and imparting the same to others without any reservation whatsoever and to facilitate the College to emerge into a magnificent and mighty launching pad to turn out technological giants, dedicated research scientists and intellectual leaders of the society who could prepare the country for a quantum jump in all fields of Science and Technology

ABOUT DEPARTMENT

- Established in: 2013
- Course offered: B.Tech Mechatronics Engineering
- Approved by AICTE New Delhi and Accredited by NAAC
- Affiliated to the University of Dr. A P J Abdul Kalam Technological University.

DEPARTMENT VISION

To develop professionally ethical and socially responsible Mechatronics engineers to serve the humanity through quality professional education.

DEPARTMENT MISSION

1) The department is committed to impart the right blend of knowledge and quality education to create professionally ethical and socially responsible graduates.
2) The department is committed to impart the awareness to meet the current challenges in technology.
3) Establish state-of-the-art laboratories to promote practical knowledge of mechatronics to meet the needs of the society

PROGRAMME EDUCATIONAL OBJECTIVES

I. Graduates shall have the ability to work in multidisciplinary environment with good professional and commitment.
II. Graduates shall have the ability to solve the complex engineering problems by applying electrical, mechanical, electronics and computer knowledge and engage in life long learning in their profession.
III. Graduates shall have the ability to lead and contribute in a team entrusted with professional social and ethical responsibilities.
IV. Graduates shall have ability to acquire scientific and engineering fundamentals necessary for higher studies and research.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write

effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSO):

1. Design and develop Mechatronics systems to solve the complex engineering problem by integrating electronics, mechanical and control systems.

2. Apply the engineering knowledge to conduct investigations of complex engineering problem related to instrumentation, control, automation, robotics and provide solutions.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Curriculum

for

B.Tech Degree

Semesters III to VIII

2016

Mechatronics

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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BRANCH:*Mechatronics*

SEMESTER - 3

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
MA201	Linear Algebra & Complex Analysis	3-1-0	4	A
MR201	C Programming	3-1-0	4	B
EE209	Electrical Technology	3-1-0	4	C
EC209	Analog Electronics	3-1-0	4	D
MR205	Science of Measurements	3-0-0	3	E
HS200/ HS210	Business Economics/Life Skills	3-0-0/ 2-0-2	3	F
EE235	Electrical Technology Lab	0-0-3	1	S
EC235	Analog Electronics Lab	0-0-3	1	T

Total Credits = 24 Hours: 28/29 Cumulative Credits= 71

SEMESTER - 4

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
MA202	Probability Distributions, Transforms and Numerical Methods	3-1-0	4	A
EC212	Linear Integrated Circuits and Digital Electronics	4-0-0	4	B
ME200	Fluid Mechanics & Machinery	3-1-0	4	C
MR202	Sensors and Actuators	3-0-0	3	D
ME210	Metallurgy and Materials Engineering	3-0-0	3	E
HS210/ HS200	Life Skills/Business Economics	2-0-2/ 3-0-0	3	F
EC234	Linear Integrated Circuits and Digital Electronics Lab	0-0-3	1	S
ME230	Fluid Mechanics and Machinery Lab	0-0-3	1	T

Total Credits = 23 Hours 28/27 Cumulative Credits= 94

BRANCH:*Mechatronics*

SEMESTER - 5

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
MR301	Linear Control Systems	3-1-0	4	A
MR303	Microprocessors and Microcontrollers	3-0-0	3	B
MR305	PLC and Data Acquisition Systems	3-0-0	3	C
MR307	Thermodynamics	3-0-0	3	D
ME220	Manufacturing Technology	3-0-0	3	E
	Elective 1	3-0-0	3	F
MR341	Design Project	0-1-2	2	S
MR331	Microprocessors and Microcontrollers Lab	0-0-3	1	T
MR333	Metrology and PLC Lab	0-0-3	1	U

Total Credits = 23 **Hours: 28** **Cumulative Credits= 117**

Elective 1:-
1. MR361 Reliability Engineering
2. MR363 Object Oriented Programming
3. MR365 Composite Materials
4. ME369 Tribology

BRANCH:*Mechatronics*

SEMESTER - 6

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
MR302	Robotics Engineering	4-0-0	4	A
MR304	Digital Image Processing and Machine Vision	3-0-0	3	B
MR306	Mechanics of Solids	3-0-0	3	C
MR308	Digital Manufacturing	3-0-0	3	D
HS300	Principles of Management	3-0-0	3	E
	Elective 2	3-0-0	3	F
MR332	Manufacturing Engineering Lab	0-0-3	1	S
MR334	Advanced Instrumentation Lab	0-0-3	1	T
MR352	Comprehensive Exam	0-1-1	2	U

Total Credits = 23 **Hours:27** **Cumulative Credits= 140**

Elective 2:-

1. MR362 Digital Signal Processing
2. MR364 Energy Engineering Management
3. MR366 Biomaterials
4. AE403 Biomedical Instrumentation
5. ME368 Marketing Management

BRANCH:*Mechatronics*

SEMESTER - 7

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
MR401	Advanced Automation Systems	4-0-0	4	A
MR403	Nanotechnology	3-0-0	3	B
MR405	Embedded Systems	3-0-0	3	C
MR407	Autotronics	3-0-0	3	D
MR409	Micro Electro Mechanical Systems	3-0-0	3	E
	Elective 3	3-0-0	3	F
MR451	Seminar & Project Preliminary	0-1-4	2	S
MR431	Mechatronics Lab	0-0-3	1	T

Total Credits = 22 Hours: 27 Cumulative Credits= 162

Elective 3:-

1. MR461 Fuzzy Logic Controllers
2. MR463 Bio Mechatronics
3. MR465 Entrepreneurship
4. ME469 Finite Element Analysis

BRANCH:*Mechatronics*

SEMESTER - 8

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
MR402	Soft Computing Techniques	3-0-0	3	A
MR404	Power Electronics and Drives	3-0-0	3	B
	Elective 4	3-0-0	3	C
	Elective 5 (Non Departmental)	3-0-0	3	D
MR492	Project		6	S

Total Credits = 18 Hours: 29 Cumulative Credits= 180

Elective 4:-

1. MR462 Industrial Electronics and Applications
2. MR464 Agile Manufacturing Systems
3. MR466 Special Electrical Machines and Applications
4. MR468 Research Methodology

ELECTIVE 5 (NON DEPARTMENTAL ELECTIVE COURSES)

(Note:- If a student has studied or chosen the elective course given within the brackets then the corresponding ND elective cannot be chosen)

1.	AO482	FLIGHT AGAIST GRAVITY
2.	AE482	INDUSTRIAL INSTRUMENTATION
3.	AE484	INSTRUMENTATION SYSTEM DESIGN
4.	AU486	NOISE, VIBRATION AND HARSHNESS
5.	BM 482	BIO MEDICAL INSTRUMENTATION (AE 403/ Bio Medical Instrumentation)
6.	BM484	MEDICAL IMAGING & IMAGE PROCESSING TECHNIQUES
7.	BT461	DESIGN OF BIOLOGICAL WASTEWATER SYSTEMS
8.	BT362	SUSTAINABLE ENERGY PROCESSES
9.	CH482	PROCESS UTILITIES AND PIPE LINE DESIGN
10.	CH484	FUEL CELL TECHNOLOGY
11.	CE482	ENVIRONMENTAL IMPACT ASSESSMENT
12.	CE484	APPLIED EARTH SYSTEMS
13.	CE486	GEO INFORMATICS FOR INFRASTRUCTURE MANAGEMENT
14.	CE488	DISASTER MANAGEMENT
15.	CE494	ENVIRONMENT HEALTH AND SAFETY
16.	CS482	DATA STRUCTURES
17.	CS484	COMPUTER GRAPHICS
18.	CS486	OBJECT ORIENTED PROGRAMMING (MR363/ OBJECTED ORIENTED PROGRAMMING)
19.	CS488	C # AND .NET PROGRAMMING
20.	EE482	ENERGY MANAGEMENT AND AUDITING (MR 364/ ENERGY ENGINEERING MANAGEMENT)
21.	EE494	INSTRUMENTATION SYSTEMS

22. EC482 BIOMEDICAL ENGINEERING

23. FT482 FOOD PROCESS ENGINEERING

24. FT484 FOOD STORAGE ENGINEERING

25. FT486 FOOD ADDITIVES AND FLAVOURING

26.IE482 FINANCIAL MANAGEMENT

27. IE484 INTRODUCTION TO BUSINESS ANALYTICS

28.IE486 DESIGN AND ANALYSIS OF EXPERIMENTS

29. IE488 TOTAL QUALITY MANAGEMENT

30.IC482 BIOMEDICAL SIGNAL PROCESSING

31. IT482 INFORMATION STORAGE MANAGEMENT

32. MA482 APPLIED LINEAR ALGEBRA

33. MA484 OPERATIONS RESEARCH

34. MA486 ADVANCED NUMERICAL COMPUTATIONS

35. MA488 CRYPTOGRAPHY

36.ME484 FINITE ELEMENT ANALYSIS

37.ME482 ENERGY CONSERVATION AND MANAGEMENT

38.ME471 OPTIMIZATION TECHNIQUES

39.MP482 PRODUCT DEVELOPMENT AND DESIGN

40. MP469 INDUSTRIAL PSYCHOLOGY & ORGANIZATIONAL BEHAVIOUR

41. MP484 PROJECT MANAGEMENT

42. MT482 INDUSTRIAL SAFETY

43. FS482 RESPONSIBLE ENGINEERING

44. SB482 DREDGERS AND HARBOUR CRAFTS

45. HS482 PROFESSIONAL ETHICS

Course No.	Course Name	L-T-P - Credits	Year of Introduction
MA201	LINEAR ALGEBRA AND COMPLEX ANALYSIS	3-1-0-4	2016

Prerequisite : Nil

Course Objectives

COURSE OBJECTIVES

- To equip the students with methods of solving a general system of linear equations.
- To familiarize them with the concept of Eigen values and diagonalization of a matrix which have many applications in Engineering.
- To understand the basic theory of functions of a complex variable and conformal Transformations**.**

Syllabus

Analyticity of complex functions-Complex differentiation-Conformal mappings-Complex integration-System of linear equations-Eigen value problem

Expected outcome .

At the end of the course students will be able to
(i) solve any given system of linear equations
(ii) find the Eigen values of a matrix and how to diagonalize a matrix
(iii) identify analytic functions and Harmonic functions.
(iv)evaluate real definite Integrals as application of Residue Theorem
(v) identify conformal mappings(vi) find regions that are mapped under certain Transformations

Text Book:

Erwin Kreyszig: Advanced Engineering Mathematics, 10th ed. Wiley

References:

1.Dennis g Zill&Patric D Shanahan-A first Course in Complex Analysis with Applications-Jones&Bartlet Publishers
2.B. S. Grewal. Higher Engineering Mathematics, Khanna Publishers, New Delhi.
3.Lipschutz, Linear Algebra,3e **(** Schaums **Series)**McGraw Hill Education India 2005
4.Complex variables introduction and applications-second edition-Mark.J.Owitz-Cambridge Publication

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Complex differentiation Text 1[13.3,13.4] Limit, continuity and derivative of complex functions	3	
	Analytic Functions	2	
	Cauchy–Riemann Equation(Proof of sufficient condition of analyticity & C R Equations in polar form not required)-Laplace's Equation	2	
	Harmonic functions, Harmonic Conjugate	2	15%
II	Conformal mapping: Text 1[17.1-17.4] Geometry of Analytic functions Conformal Mapping,	1	
	Mapping $w = z^2$ conformality of $w = e^z$.	2	15%

	The mapping $w = z + \frac{1}{z}$ Properties of $w = \frac{1}{z}$ Circles and straight lines, extended complex plane, fixed points Special linear fractional Transformations, Cross Ratio, Cross Ratio property-Mapping of disks and half planes Conformal mapping by $w = \sin z$ & $w = \cos z$ (Assignment: Application of analytic functions in Engineering)	1 3 3	
FIRST INTERNAL EXAMINATION			
III	Complex Integration. Text 1[14.1-14.4] [15.4&16.1] Definition Complex Line Integrals, First Evaluation Method, Second Evaluation Method Cauchy's Integral Theorem(without proof), Independence of path(without proof), Cauchy's Integral Theorem for Multiply Connected Domains (without proof) Cauchy's Integral Formula- Derivatives of Analytic Functions(without proof)Application of derivative of Analytical Functions Taylor and Maclaurin series(without proof), Power series as Taylor series, Practical methods(without proof) Laurent's series (without proof)	2 2 2 2 2	15%
IV	Residue Integration Text 1 [16.2-16.4] Singularities, Zeros, Poles, Essential singularity, Zeros of analytic functions Residue Integration Method, Formulas for Residues, Several singularities inside the contour Residue Theorem. Evaluation of Real Integrals (i) Integrals of rational functions of $\sin\theta$ and $\cos\theta$ (ii)Integrals of the type $\int_{-\infty}^{\infty} f(x)dx$ (Type I, Integrals from 0 to ∞) (Assignment : Application of Complex integration in Engineering)	2 4 3	15%
SECOND INTERNAL EXAMINATION			
V	Linear system of Equations Text 1(7.3-7.5) Linear systems of Equations, Coefficient Matrix, Augmented Matrix Gauss Elimination and back substitution, Elementary row operations, Row equivalent systems, Gauss elimination-Three possible cases, Row Echelon form and Information from it.	1 5	20%

	Linear independence-rank of a matrix Vector Space-Dimension-basis-vector space $\mathbf{R^3}$ Solution of linear systems, Fundamental theorem of non-homogeneous linear systems(Without proof)-Homogeneous linear systems (Theory only	2 1	
VI	Matrix Eigen value Problem Text 1.(8.1,8.3 &8.4) Determination of Eigen values and Eigen vectors-Eigen space Symmetric, Skew Symmetric and Orthogonal matrices –simple properties (without proof) Basis of Eigen vectors- Similar matrices Diagonalization of a matrix-Quadratic forms- Principal axis theorem(without proof) (Assignment-Some applications of Eigen values(8.2))	 3 2 4	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks : 100 Exam Duration: 3 hours

The question paper will consist of 3 parts.

Part A will have 3 questions of 15 marks each uniformly covering modules I and II. Each question may have two sub questions.

Part B will have 3 questions of 15 marks each uniformly covering modules III and IV. Each question may have two sub questions.

Part C will have 3 questions of 20 marks each uniformly covering modules V and VI. Each question may have three sub questions.

Any two questions from each part have to be answered.

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR201	C Programming	3-1-0 -4	2016

Pre requisites : Nil

Course Objectives

- To impart the basic concepts of computer and information technology
- To develop skill in problem solving concepts through learning C programming with a practical approach.

Syllabus

Introduction to Computers- Evolution and comparative study of processors- Machine language, assembly language, and high level language- Concept of Program and data, System software- Windows, and Linux. Compilers and assemblers, Computer networks: LAN, WiFi- Basic elements of C- Input and Output functions- Functions and Program structures- Structures -Recursion- Arrays- Pointers-Concept of a file- Example programs.

Expected outcome

i. Students will acquire knowledge on the components and working of computers.

ii. Students will get knowledge in computer networks and operating systems.

iii. Students will understand the role of compilers, pointers, arrays etc in C programming.

Text Book:

1. P. Norton, *Peter Norton's Introduction to Computers*, Tata McGraw Hill, New Delhi.

2. E. Balaguruswamy, *Programming in ANSI C*, 3rd ed., Tata McGraw Hill, New Delhi, 2004

References:

1. B. Gottfried, *Programming with C*, 2nd ed, Tata McGraw Hill, New Delhi, 2006

2. B. W. Kernighan, and D. M. Ritchie, *The C Programming Language*, Prentice Hall of India, New Delhi, 1988

3. K. N. King. *C Programming: A Modern Approach*, 2nd ed., W. W. Norton & Company, 2008

4. P. Norton, *Peter Norton's Computing Fundamentals*, 6th ed., Tata McGraw Hill, New Delhi, 2004.

5. S. Kochan, *Programming in C*, CBS publishers & distributors

6. M. Meyer, R. Baber, B. Pfaffenberger, *Computers in Your Future*, 3rd ed., Pearson Education India

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to Computers: CPU, Memory, input-output devices, secondary storage devices, Processor Concepts - Evolution and comparative study of processors. Machine language, assembly language, and high level language. Inside a PC, Latest trends and technologies of storage, memory, processor, printing etc	9	15%
II	Concept of Program and data, System software - BIOS, Operating System- Definition-Functions-Windows, and Linux. Compilers and assemblers, Computer networks: LAN, WiFi.	9	15%
FIRST INTERNAL EXAMINATION			

III	Basic elements of C: Flow chart and algorithm – Development of algorithms for simple problems. Structure of C program – Operators and expressions – Procedure and order of evaluation – Input and Output functions. while, do-while and for statements, if, if-else, switch, break, continue, goto, and labels. Programming examples.	10	15%
IV	Functions and Program structures: Functions – declaring, defining, and accessing functions – parameter passing methods – Recursion – Storage classes – extern, auto, register and static. Library functions. Header files – C pre-processor. Example programs.	9	15%
SECOND INTERNAL EXAMINATION			
V	Arrays: Defining and processing arrays – passing arrays to functions – two dimensional and multidimensional arrays – application of arrays. Example programs.	10	20%
VI	Structures – declaration, definition and initialization of structures, unions, Pointers: Concepts, declaration, initialization of pointer variables simple examples Concept of a file – File operations File pointer.	9	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions
(3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
EC209	Analog Electronics	3-1-0-4	2016

Prerequisites :Nil

Course Objectives

- To familiarize basic electronic elements and their characteristics
- To develop understanding about BJT and FET circuits
- To understand the concept of power amplifier and differential amplifiers

Syllabus

Diode: Diode as a circuit element-diode clipping circuits-clamping circuits-voltage regulators-BJT: Operating point of a BJT-thermal runaway-h parameter model of a BJT-frequency response of amplifiers-FET: Construction and characteristics of JFET and MOSFET-Feedback: - Concepts – negative and positive feedback-Power Amplifiers- Class A, B, AB, C, D & S power amplifier-Differential Amplifiers:- The BJT differential pair- Large and small signal operation-MOS differential amplifier- Large and small signal operation-UJT- 555 Timer IC, PLL.

Expected outcome.

- Will get knowledge on electronic elements and their characteristics.

Text Book:

1. Allen Mottershead, *Electronic Devices and Circuits: An Introduction*, Prentice Hall of India.
2. V. Boylestad and Nashelsky, *Electronic Devices and Circuits*, Pearson Education
3. Ramakant A Gayakwad, *Op- Amps and Linear Integrated Circuits*, Prentice Hall of India

References:

1. Schilling and Belove, Electronic Circuits, McGraw Hill
2. Theodore F. Bogart Jr., Electronic Devices and Circuits,
3. Coughlin and Driscoll, Operational amplifiers and Linear Integrated Circuits,
4. K. R. Botkar, Integrated Circuits, Khanna Publishers
5. Somanathan Nair, Linear Integrated Circuits – Analsysis, Design & Application, Wiley-India

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**Diode:** Diode as a circuit element - load line - piecewise linear model – single-phase half wave and full wave rectifier circuits – voltage regulation - ripple factor - rectifier efficiency - bridge rectifier - rectifier filters - diode clipping circuits - single level and two level clippers - clamping circuits –Zener diodes - Zener voltage regulators.	9	15%
II	**BJT:** Operating point of a BJT – DC biasing - bias stability - thermal runaway - AC Concepts –role of capacitors in amplifiers – common emitter AC equivalent circuit - amplifier gain and impedance calculations- h parameter model of a BJT –cascaded amplifiers, frequency response of amplifiers	9	15%

FIRST INTERNAL EXAMINATION			
III	**FET** Construction and characteristics of JFET and MOSFET, biasing a JFET and MOSFET, JFET and MOSFET small signal model - CS and CD amplifiers. feedback: - Concepts – negative and positive feedback feedback -feedback connection types - practical feedback circuits	9	15%
IV	**Power Amplifiers** Class A, B, AB, C, D & S power amplifiers - harmonic distortion efficiency -wide band amplifier - broad banding techniques - low frequency and high frequency compensation -cascode amplifier - broad banding using inductive loads - Darlington pairs.	10	15%
SECOND INTERNAL EXAMINATION			
V	**OSCILLATORS & MULTI VIBRATORS** Classification of oscillators – Barkhausen criteria- operation and analysis of RC phase shift – Hartely and Colpitts oscillators – Multi vibrators – astable, mono stable and bi stable multi vibrators	9	20%
VI	**UJT**-construction –working-UJT oscillator-UPS-brief overview of online UPS &off line UPS-SMPS-operation **Timer IC 555**: Functional diagram- astable and monostable modes **Phase Locked Loops**: Principles – building blocks of PLL-VCO-lock and capture ranges - capture process - frequency multiplication using PLL	10	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions
(3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE209	Electrical Technology	3-1-0 -4	2016

Prerequisite : Nil

Course Objectives

- To understand about the network Elements, types of networks & analysis of complex circuits using Mesh current & Nodal voltage method.
- To impart knowledge on the solution methods of AC and DC circuits.
- To understand the working principle and characteristics of all electrical machines

Syllabus

Types of Networks- mesh current & Nodal voltage method for DC and AC circuits-Basics of Circuit theorems-AC circuits- RLC circuits- series and parallel resonance-Three phase circuits- Power measurements in three phase circuits-DC machines construction – working- EMF equation – Characteristics of DC shunt and series motor and generator-Starters- Concept of transformers-EMF equation- concept of rotating magnetic field- working principle of induction motors-special machines and their application.

Expected outcome.

i. Understand the circuit analysis and theorems.
ii. Understand the concept of three phase RLC circuits.
iii. Get knowledge in construction and working of dc machines
iv. Get knowledge in special machines and their applications.
v. Understand the construction and working of induction machines.

Text Book:

1. Theraja B.L., Theraja A.K. *A Text Book of Electrical Technology*, Vol.II "AC & DC Machines", publication division of Nirja construction & development (p) Ltd., New Delhi, 1994.

2. Sudhakar, A. and Shyam Mojan, S.P. *Circuits and Networks Analysis and Synthesis*, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 1994.

References:

1. Raina K.B., Bhattacharya S.K. *Electrical Design Estimating & Costing*, New Age International P Ltd.,2001.

2. Muthusubramanian R & Ayyappan K, *Circuit Theory*, Anuradha Publishign Pvt Ltd., Tamil Nadu 1999.

3. Arumugam & Premkumar, *Electric Circuit Theory*, Khanna Publishers. 2002

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**BASICS OF CIRCUIT ANALYSIS** Types of Networks – Sources transformation – Star – Delta transformation – formation of matrix equation and analysis of circuits using mesh current & Nodal voltage method for DC and AC circuits.	10	15%
II	**BASICS OF CIRCUIT THEOREMS** Thevenin's theorem – Norton's theorem – superposition theorem – maximum power transfer theorem – statement, illustration & application to DC circuits.	9	15%

FIRST INTERNAL EXAMINATION			
III	**AC CIRCUITS:** Review of Basic concepts – solution of RLC circuit – power – power factor and energy relation – series resonance – parallel resonance – Q factor – bandwidth. Three phase star-delta connections – characteristic equations – phasor diagrams – solution of 3-phase balanced circuits & unbalanced circuits – Three phase power measurement suing watt meters	10	15%
IV	**DC MACHINES:** Review of constructional details – Working principle of DC generator – EMF equation – No load & load characteristics of shunt generator – working principle of DC motor – back emf – equations for torque & power – characteristics of shunt, series & compound motors – Necessity of starters and their types— power stages – efficiency.	9	15%
SECOND INTERNAL EXAMINATION			
V	**TRANSFORMERS** Construction – working principle – emf equation & voltage regulation – vector diagram **3-PHASE INDUCTION MOTORS** Production of rotating magnetic field – torque equation, torque – slip characteristics – power stages and efficiency – simple problems – starters & methods of speed control (quantitative treatment only).	10	20%
VI	**SPECIAL MACHINES / APPLICATIONS** (Qualitative treatment only) Working principle of single phase induction motor – capacitor start & capacitor run motors – Universal motor – stepper motor – servomotor - Synchronous motor Selection of motors with justifications for the following services, *Machine tools *Washing machine *Cranes *WetGrinder *Steel mills * Mixie *Hoist *Electric traction	9	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS

8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS

5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions

(3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS

4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions

(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR205	Science of Measurements	3-0-0-3	2016

Prerequisites : Nil

Course Objectives

- To understand the basic principles of measurements.
- To learn about various methods of measuring instruments

Syllabus

Mechanical measurement- direct comparison and indirect comparison-the generalized measurement system- types of input quantities'- calibration- uncertainty- systematic and random errors-common type of errors- terms used in rating instrument performance- propagation of uncertainty- Kline and Mclintock approach-Zero, First and Second order instruments- input output configuration of generalized measurement system-Sensors – primary and secondary transducers – active and passive transducers - Measurement of temperature – expansion thermometers- resistance thermometers– thermo electric thermometers-Pyrometers – optical, total radiation and photo electric pyrometers- Measurement of flow -Measurement of low pressure- measurement of high pressure – Linear and angular measurement- Measurement of surface roughness - Measurement of screw thread profiles – gear tooth measurement

Expected outcome.

- The students will pick up familiarity with basics of measurements, methods of measuring various parameters and dimensions in engineering applications.

Text Book:

1. Ernest O Doebelin, Measurement Systems Application and Design, Mc Graw- Hill Publishing Company
2. Jain R.K., "Engineering Metrology", Khanna Publishers.
3. Beckwith, Marangoni, Lienhard, "Mechanical Measurements", Pearson Education.

References:

1. Gupta S.C, "Engineering Metrology", Dhanpat rai Publications, 2005
2. Jayal A.K, "Instrumentation and Mechanical Measurements", Galgotia Publications 2000
3. A.K Sawhney "A course in Mechanical Measurements and Instrumentation & Control"
4. Donald Deckman, "Industrial Instrumentation", Wiley Eastern, 1985.
5. Alan S. Morris, "The Essence of Measurement", Prentice Hall of India, 1997

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Mechanical measurement- direct comparison and indirect comparison-the generalized measurement system- types of input quantities- calibration- uncertainty- systematic and random errors-common - type of errors- classification of errors- terms used in rating instrument performance- introduction to uncertainty analysis-propagation of uncertainty- Kline and Mclintock approach .	7	15%
II	Zero, First and Second order instruments –input output configuration of generalized measurement system-methods for correcting for spurious inputs- inherent insensitivity-high gain feedback-signal filtering and opposing input	7	15%
FIRST INTERNAL EXAMINATION			

III	Sensors – primary and secondary transducers – active and passive transducers - linear variable differential transformer – construction and characteristics– capacitance transducers – piezo electric transducers – photoelectric sensors – Hall Effect transducers – Resistance wire strain gauges-gauge factor-measuring circuits-calibration	7	15%
IV	Expansion thermometers – liquid in glass thermometer – partial and total immersion thermometers – resistance thermometers– thermistors – Thermo electric thermometers – laws of thermocouples –Pyrometers – optical, total radiation and photo electric pyrometers Measurement of flow – rotameter - magnetic flow meters – hotwire anemometers – Measurement of low pressure – McLeod gauge – thermal conductivity gauge – measurement of high pressure – bulk modulus gauge	7	15%
SECOND INTERNAL EXAMINATION			
V	Linear and angular measurement: slip gauges - Measurement of angles – sine bar – sine center – angle gauges – optical instruments for angular measurement- auto collimator – applications – straightness and squareness –angle dekkor – Measurement of surface roughness – surface texture – methods of measuring surface finish -the Talysurf instrument – the profilograph – Tomlinson surface meter – Tracer type profilograph	7	20%
VI	Measurement of screw thread profiles – errors in pitch– microscopic method – measurement of internal thread – measurement of effective diameter – two wire and three wire method – measurement of root diameter – gear tooth measurement – measurement of gear profile – tooth thickness – tooth spacing – pitch circle diameter – Parkinson s gear tester.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS

8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS

5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions

(3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS

4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions

(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE235	Electrical Technology lab	0-0-3-1	2016

Prerequisite : EE209 Electrical technology

Course Objectives

- To impart working knowledge on electrical circuits, A C machines, DC machines and transformers.

List of Exercises/Experiments : (Minimum 10 experiments are mandatory)

1. Verification of Thevenin's theorem
2. Verification of Norton's theorem
3. Verification of Superposition theorem
4. Verification of Maximum power transfer theorem
5. Power measurement in 3 phase balanced circuits
6. Power measurement in 3 phase unbalanced circuits
7. Load test on DC shunt motor
8. Load test on DC series motor
9. Speed control of DC shunt motor
10. Open circuit characteristics of DC series motor.
11. Open circuit characteristics of dc shunt motors
12. Swinburne's test and separation of losses in DC machine.
13. Load test on single phase transformer
14. Load test on 3-phase induction motor
15. No load test on 3- phase induction motors.

List of major equipment

DC shunt motor, DC series motor, DC series motor, single phase transformer, 3-phase induction motor, Watt meters, Ammeters, voltmeters, Tachometers.

Expected outcome.

- On completion of this lab course, the students will be able to understand the concept of electric circuits and the performance characteristics of electrical machines.

Text Book:

Theraja B.L., Theraja A.K. *A Text Book of Electrical Technology*, Vol.II "AC & DC Machines", publication division of Nirja construction & development (p) Ltd., New Delhi.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EC235	ANALOG ELECTRONICS LABORATORY	0-0-3:1	2016

Prerequisite: EC209 Analog electronics

Course Objectives

- To develop working knowledge on electronic devices and their performance characteristics

List of Exercises/Experiments : (Ten experiments are mandatory)

1. Study & Use of CRO: Measurement of current voltage, frequency and phase shift.
2. Diode Clipping Circuits
3. Clamping Circuits
4. Rectifiers and filters with and without shunt capacitors- Characteristics full wave rectifier- Ripple factor, Rectification efficiency, and % regulation
5. RC coupled amplifier using BJT in CE configuration- Measurement of gain, input and output impedance and frequency response
6. FET amplifier- Measurement of voltage gain, current gain, input and output impedance
7. Darlington Emitter Follower
8. R.C. Phase Shift Oscillator using BJT or Op- Amp
9. Characteristics of voltage regulators- Design and testing of: a) simple zener voltage regulator b) zener regulator with emitter follower output
10. Series & Parallel Resonance Circuits
11. Voltage Series Feedback Amplifier
12. Class 'B' Push-Pull Amplifier
13. Astable and monostable multivibrators using IC 555
14. Design of PLL for given lock and capture ranges& frequency multiplication
15. Applications using PLL

List of major equipments

CRO, Function generator, Regulated power supply , Dual power supply, Digital multimeter, Ammeter ,Voltmeter.

Expected outcome.

- On completion of the course the student will be able to understand the working of electrical devices ,their performance characteristics and will be able to design circuits for various electronic devices

Text Book:

Allen Mottershead, *Electronic Devices and Circuits: An Introduction*, Prentice Hall of India

Course No.	Course Name	L-T-P - Credits	Year of Introduction
MA202	Probability distributions, Transforms and Numerical Methods	3-1-0-4	2016

Prerequisite: Nil

Course Objectives

- To introduce the concept of random variables, probability distributions, specific discrete and continuous distributions with practical application in various Engineering and social life situations.
- To know Laplace and Fourier transforms which has wide application in all Engineering courses.
- To enable the students to solve various engineering problems using numerical methods.

Syllabus

Discrete random variables and Discrete Probability Distribution.
Continuous Random variables and Continuous Probability Distribution.
Fourier transforms.
Laplace Transforms.
Numerical methods-solution of Algebraic and transcendental Equations, Interpolation.
Numerical solution of system of Equations. Numerical Integration, Numerical solution of ordinary differential equation of First order.

Expected outcome .

After the completion of the course student is expected to have concept of
(i) Discrete and continuous probability density functions and special probability distributions.
(ii) Laplace and Fourier transforms and apply them in their Engineering branch
(iii) numerical methods and their applications in solving Engineering problems.

Text Books:

1. Miller and Freund's "Probability and statistics for Engineers"-Pearson-Eighth Edition.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley, 2015.

References:

1. V. Sundarapandian, "Probability, Statistics and Queuing theory", PHI Learning, 2009.
2. C. Ray Wylie and Louis C. Barrett, "Advanced Engineering Mathematics"-Sixth Edition.
3. Jay L. Devore, "Probability and Statistics for Engineering and Science"-Eight Edition.
4. Steven C. Chapra and Raymond P. Canale, "Numerical Methods for Engineers"-Sixth Edition-Mc Graw Hill.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**Discrete Probability Distributions.** (Relevant topics in section 4.1,4,2,4.4,4.6 Text1) Discrete Random Variables, Probability distribution function, Cumulative distribution function. Mean and Variance of Discrete Probability Distribution. Binomial Distribution-Mean and variance. Poisson Approximation to the Binomial Distribution. Poisson distribution-Mean and variance.	2 2 2 2	15%

II	**Continuous Probability Distributions.** (Relevant topics in section 5.1,5.2,5.5,5.7 Text1) Continuous Random Variable, Probability density function, Cumulative density function, Mean and variance. Normal Distribution, Mean and variance (without proof). Uniform Distribution.Mean and variance. Exponential Distribution, Mean and variance.	 2 4 2 2	15%
FIRST INTERNAL EXAMINATION			
III	**Fourier Integrals and transforms. (**Relevant topics in section 11.7, 11.8, 11.9 Text2) Fourier Integrals. Fourier integral theorem (without proof). Fourier Transform and inverse transform. Fourier Sine & Cosine Transform, inverse transform.	 3 3 3	15%
IV	**Laplace transforms. (**Relevant topics in section 6.1,6.2,6.3,6.5,6.6 Text2**)** Laplace Transforms, linearity, first shifting Theorem. Transform of derivative and Integral, Inverse Laplace transform, Solution of ordinary differential equation using Laplace transform. Unit step function, second shifting theorem. Convolution Theorem (without proof). Differentiation and Integration of transforms.	 3 4 2 2 2	15%
SECOND INTERNAL EXAMINATION			
V	**Numerical Techniques**.(Relevant topics in section.19.1,19.2,19.3 Text2) Solution Of equations by Iteration, Newton- Raphson Method. Interpolation of Unequal intervals-Lagrange's Interpolation formula. Interpolation of Equal intervals-Newton's forward difference formula, Newton's Backward difference formula.	 2 2 3	20%
VI	**Numerical Techniques**. (Relevant topics in section 19.5,20.1,20.3, 21.1 Text2) Solution to linear System- Gauss Elimination, Gauss Seidal Iteration Method. Numeric Integration-Trapezoidal Rule, Simpson's 1/3 Rule. Numerical solution of firstorder ODE-Euler method, Runge-Kutta Method (fourth order).	 3 3 3	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks : 100 Exam Duration: 3 hours

The question paper will consist of 3 parts.

Part A will have 3 questions of 15 marks each uniformly covering modules I and II. Each question may have two sub questions.

Part B will have 3 questions of 15 marks each uniformly covering modules III and IV. Each question may have two sub questions.

Part C will have 3 questions of 20 marks each uniformly covering modules V and VI. Each question may have three sub questions.

Any two questions from each part have to be answered.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EC212	Linear Integrated Circuits and Digital Electronics	4-0-0 -4	2016

Prerequisites :Nil

Course Objectives

- To introduce the concepts for realizing functional building blocks in ICs and applications of IC.
- To know the fundamentals of combinational and sequential digital circuits.

Syllabus

Ideal OP-AMP characteristics, DC characteristics- AC characteristics- offset voltage and current: voltage series feedback - shunt feedback amplifiers, differential amplifier- frequency response of OP-AMP- Basic applications of OP-AMP – summer, differentiator ,integrator, V/I &I/V converter-Instrumentation amplifier-Basic Comparators- regenerative comparators- multivibrators- waveform Generators- clippers- clampers- peak detector- S/H circuit- First and Second order active filter-, D/A converter (R-2R ladder and weighted resistor types)- A/D converter - Dual slope- successive approximation and flash types- 555 Timer circuit – Functional block- characteristics & applications:- IC 566-voltage controlled oscillator circuit- OP-AMP-Voltage regulator-Series- Shunt and Switching regulator- Review of number system:- types and conversion- codes- Boolean algebra: De-Morgan's theorem- Minimization of Boolean function using K-maps & Quine McCluskey method- Combinational circuits: -Adder- subtractors- code converters- encoders- decoders- multiplexers and demultiplexers- Combinational Logic by using Multiplexers- ROM- PLA and PAL-Memories - ROM, Static and Dynamic RAM- Read/Write Memory- EPROM, EEPROM-Flip flops – SR- D- JK - T and Master Slave FF- Shift registers-Counters-Asynchronous and Synchronous Counters- Up-Down Counter- Modulo Counter- Ring Counter-Analysis of Asynchronous Counters

Expected outcome:

- The students will learn to know about the IC'S and their application, digital circuits, combinational and sequential circuits.

Text Book:

1. Ramakant A.Gayakward, Op-amps and Linear Integrated Circuits, IV edition, Pearson Education, 2003 / PHI.
2. D.Roy Choudhary, Sheil B.Jani, Linear Integrated Circuits, II edition, New Age, 2003.
3. M. Morris Mano, Digital Logic and Computer Design, Prentice Hall of India, 2002

References:

1. Robert F.Coughlin, Fredrick F.Driscoll, Op-amp and Linear ICs, Pearson Education, 4th edition, 2002 /PHI.
2. David A.Bell, Op-amp & Linear ICs, Prentice Hall of India, 2nd edition, 1997.
3. Charles H.Roth, Fundamentals Logic Design, Jaico Publishing, IV edition, 2002.
4. Floyd, Digital Fundamentals, 8th edition, Pearson Education, 2003.

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	OP-AMP-Ideal OP-AMP characteristic-offset voltage and current: voltage series feedback and shunt feedback amplifiers, differential amplifier- frequency response of OP-AMP- Basic applications of op-amp – differentiator and integrator, V/I &I/V converter**.**	9	15%
II	Instrumentation amplifier- Basic Comparators- regenerative comparators- multivibrators- waveform generators- clippers, clampers- peak detector- S/H circuit- isolation amplifier - log and antilog amplifiers analog multipliers	9	15%
FIRST INTERNAL EXAMINATION			
III	D/A converter (R-2R ladder and weighted resistor types)- A/D converter - Dual slope, successive approximation and flash types Active filters-filter transfer function-Butterworth and Chebyshev filters-First order and second order function for low-pass, high-pass, band –pass, band-stop and all –pass filters	9	15%
IV	Review of number system- types and conversion- codes- one's complement and two's complement-Arithmetic operations of Binary Boolean algebra: De-Morgan's theorem- Minimization of Boolean function using K-maps &QuineMcCluskey method.	9	15%
SECOND INTERNAL EXAMINATION			
V	Combinational circuits: Adder- subtractor- code converters, encoders, decoders, multiplexers and demultiplexers. Implementation of Combinational Logic by using Multiplexers, ROM, PLA and PAL. Memories – ROM- Static and Dynamic RAM- Read/Write Memory- EPROM- EEPROM	10	20%
VI	Flip flops - SR, D, JK , T and Master Slave Flip Flop -Shift registers -Counters-Asynchronous and Synchronous Counters-Up-Down Counter- Modulo Counter- Ring Counter-Analysis of Asynchronous Counters-sequence detector.	10	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS

8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS

5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions (3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS

4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions

(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR202	Sensors and Actuators	3-0-0-3	2016

Prerequisites :Nil

Course Objectives

- To understand the main components of the hydraulic and pneumatic systems
- To learn controls used in NC Machines and fluidic control systems

Syllabus

Industrial Prime movers - hydraulic and pneumatic systems-pumps – types of pumps- filters and their types- Compressors - relief valves-non relieving pressure regulator. Control valves-graphic symbols –Types of control valves- Actuators-linear actuator-principle of operation-simple cylinder- -seals-anti extrusion rings-rotary actuators-constructional details-limited motion rotary actuators - Speed control of actuators - speed control by pump volume-meter in speed control-meter out speed control for overhauling load-bleed off speed control-pressure compensated flow control valve - signals and standards - the flapper nozzle - volume booster - pneumatic controllers – types of pneumatic controllers - Fail up and fail down actuators – Converters - PI and IP converters. Controls in NC Machines - stepping motors - encoders - resolvers - inductosyn – tachogenerators - Coanda effect - basic fluidic devices - fluidic logic gates - bistable flipflop - OR and NOR gates - exclusive OR gates - fluidic sensors - backpressure sensor - proximity sensor

Expected outcome.

- Upon completion of this course, students will be familiar with the main components used in hydraulic and pneumatic systems and gain knowledge on the controls in NC Machines and fluidic systems.

Text Book:

1. Andrew Parr, 'Hydraulics and Pneumatics', Jaico Publishing House ,Mumbai

References:

1. Anthony Esposito, 'Fluid Power', Pearson Education,
2. Yoram Koren, 'Computer control of Manufacturing Systems', TataMc.Graw Hill Publishers, New Delhi

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Industrial Prime movers-brief comparison of electrical, hydraulic and pneumatic systems-hydraulic pumps-pressure regulation-gear pump- lobe pump- unbalanced and balanced type vane pump-variable displacement vane pump-radial piston pump-piston pump with stationary cam and rotating block-axial pump with swash plate-bent axis pump-combination pumps-loading valves-filters and location of filters-full flow filter-proportional flow filter-edge type filter.	7	15%
II	Compressors-single cylinder compressor- double acting compressor and two stage compressor-combined two stage compressor-diaphragm compressor-screw compressor-rotary compressor-liquid ring compressor –lobe compressor-non positive displacement compressor-air receiver and compressor control-receiver pressure control via motor start stop –receiver pressure control using compressor outlet valve and inlet valve-stages of air treatment –filters-air driers-deliquescent and adsorption driers-lubricators-types of pressure regulators-relief	7	15%

	valves-non relieving pressure regulator-relieving pressure regulator-service units		
FIRST INTERNAL EXAMINATION			
III	Control valves-graphic symbols –Types of control valves-simple 2/2 poppet valve-3/2poppet valve 4/2 poppet valve-spool valves- two way and four way spool valves-three position four way valve- pilot operated 3/2 valve-rotary valve-Check valve-simple check valve-right angle check valve-pilot operated check valve-restriction check valve-shuttle valve-fast exhaust valves-sequence valve-time delay valve-single stage infinite position valve-flapper jet servo valve	7	15%
IV	Actuators-linear actuator-principle of operation-simple cylinder-cylinder with equal extend/ retract force-single acting cylinder-cylinder speed calculation-construction details of cylinder-cylinder cushioning-side load and stop tube-two stage telescopic piston-impact cylinder-mounting of cylinders-cylinder seals-static -anti extrusion rings-rotary actuators-constructional details-limited motion rotary actuators-Speed control of actuators-speed control by pump volume-meter in speed control-meter out speed control for overhauling load-bleed off speed control-pressure compensated flow control valve.	7	15%
SECOND INTERNAL EXAMINATION			
V	Process control pneumatics - signals and standards - the flapper nozzle - volume booster - air relay and force balance - pneumatic controllers - proportional pneumatic control - proportional plus integral pneumatic control - proportional plus integral plus derivative pneumatic control - Fail up and fail down actuators –Converters- PI and IP converters	7	20%
VI	Controls in NC Machines and fluidic control - stepping motors - feedback devices- encoders - resolvers - inductosyn – tachogenerators - principles of fluid logic control -Coanda effect - basic fluidic devices - fluidic logic gates - bistable flipflop - OR and NOR gates - exclusive OR gates - fluidic sensors - backpressure sensor - cone jet proximity sensor - interruptible jet sensor.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS

8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS

5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions (3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS

4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions

(2 x15 = 30 marks)

Course Number	Course Name	L-T-P-Credits	Year of Introduction
ME200	Fluid mechanics and Machinery	3-1-0-4	2016

Prerequisite : Nil

Course Objectives:

- To introduce students, the fundamental concepts related to the mechanics of fluids.
- To understand the basic principles of fluid machines and devices.
- To apply acquired knowledge on real life problems.
- To analyze existing fluid systems and design new fluid systems.

Syllabus

Fundamental Concepts, fluid statics and dynamics, fluid kinematics, boundary layer theory, hydraulic turbines, positive displacement pumps, rotary motion of liquids**,** centrifugal pump, pumping devices.

Expected Outcome

Up on completion of course the students might be in a position to:

i. Analyze flow problems associated with statics, kinematics and dynamics of fluids.
ii. Design and analyze fluid devices such as water turbines and pumps.
iii. Understand and rectify problems faced in practical cases of engineering applications.

Text Book:

1. Modi P. N. and S. M. Seth, *Hydraulics & Fluid Mechanics*, S.B.H Publishers, New Delhi, 2002.
2. Kumar D. S., *Fluid Mechanics and Fluid Power Engineering*, S. K. Kataria & Sons, New Delhi, 1998.

References:

1. J. F. Douglas, "Fluid Mechanics", Pearson education.
2. Cengel Y. A. and J. M. Cimbala, Fluid Mechanics, Tata McGraw Hill, 2013
3. Robert W. Fox and Mc Donald, "Introduction to fluid dynamics", John Wiley and sons
4. K. Subrahmanya, "Theory and applications of fluid mechanics", (TMH)
5. Shames. I. H, "Mechanics of fluids".
6. Jagadish Lal, "Fluid mechanics and Hydraulic machines".
7. R K Bansal, "Hydraulic Machines"

Course Plan

Module	Contents	Hours	Sem. exam marks
I	**Fundamental concepts:** Properties of fluid - density, specific weight, viscosity, surface tension, capillarity, vapour pressure, bulk modulus, compressibility, velocity, rate of shear strain, Newton's law of viscosity, Newtonian and non-Newtonian fluids, real and ideal fluids, incompressible and compressible fluids.	6	15%

II	**Fluid statics:** Atmospheric pressure, gauge pressure and absolute pressure. Pascal's Law, measurement of pressure - piezo meter, manometers, pressure gauges, energies in flowing fluid, head - pressure, dynamic, static and total head, forces on planar and curved surfaces immersed in fluids, centre of pressure, buoyancy, equilibrium of floating bodies, metacentre and metacentric height.	10	15%
First Internal Exam			
III	**Fluid kinematics and dynamics:** Classification of flow -1D, 2D and 3D flow, steady, unsteady, uniform, non-uniform, rotational, irrotational, laminar and turbulent flow, path line, streak line and stream line. Continuity equation, Euler's equation, Bernoulli's equation. Reynolds experiment, Reynold's number. Hagen- Poiseuille equation, head loss due to friction, friction, Darcy- Weisbach equation, Chezy's formula, compounding pipes, branching of pipes, siphon effect, water hammer transmission of power through pipes (simple problems)	8	15%
IV	**Boundary layer theory:** Basic concepts, laminar and turbulent boundary layer, displacement, momentum, energy thickness, drag and lift, separation of boundary layer. Flow rate measurements- venturi and orifice meters, notches and weirs (description only for notches, weirs and meters), practical applications, velocity measurements- Pitot tube and Pitot –static tube.	10	15%
Second Internal Exam			
V	**Hydraulic turbines :** Impact of jets on vanes - flat, curved, stationary and moving vanes - radial flow over vanes. Impulse and Reaction Turbines – Pelton Wheel constructional features - speed ratio, jet ratio & work done , losses and efficiencies, inward and outward flow reaction turbines- Francis turbine constructional features, work done and efficiencies – axial flow turbine (Kaplan) constructional features, work done and efficiencies, draft tubes, surge tanks, cavitation in turbines.	10	20%
VI	**Positive displacement pumps:** reciprocating pump, indicator diagram, air vessels and their purposes, slip, negative slip and work required and efficiency, effect of acceleration and friction on indicator diagram (no derivations), multi cylinder pumps. **Rotary motion of liquids:** – free, forced and spiral vortex flows, (no derivations), centrifugal pump, working principle, impeller, casings, manometric head, work, efficiency and losses, priming, specific speed, multistage pumps, selection of pumps, pump characteristics.	10	20%
End Semester Exam			

Question Paper Pattern

Max. marks: 100, Time: 3 hrs
The question paper should consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME210	**METALLURGY AND MATERIALS ENGINEERING**	**3-0-0-3**	**2016**

Prerequisite: nil

Course Objectives:

1. To provide fundamental science relevant to materials
2. To provide physical concepts of atomic radius, atomic structure, chemical bonds, crystalline and non-crystalline materials and defects of crystal structures, grain size, strengthening mechanisms, heat treatment of metals with mechanical properties and changes in structure
3. To enable students to be more aware of the behavior of materials in engineering applications and select the materials for various engineering applications.
4. To understand the causes behind metal failure and deformation
5. To determine properties of unknown materials and develop an awareness to apply this knowledge in material design.

Syllabus:-Chemical bonds – crystallography- imperfections- crystallization- diffusion- phase diagrams-heat treatment – strengthening mechanisms- hot and cold working – alloying- ferrous and non ferrous alloys- fatigue-creep- basics, need, properties and applications of modern engineering materials.

Expected outcome: At the end of the course students will be able to

1. Identify the crystal structures of metallic materials.
2. Analyze the binary phase diagrams of alloys Fe-Fe_3C, etc.
3. Correlate the microstructure with properties, processing and performance of metals.
4. Recognize the failure of metals with structural change.
5. Select materials for design and construction.
6. Apply core concepts in materials science to solve engineering problems.

Text Books

1. Raghavan V, Material Science and Engineering, Prentice Hall,2004
2. Jose S and Mathew E V, Metallurgy and Materials Science, Pentagon, 2011

Reference

1 Anderson J.C. *et.al*., Material Science for Engineers,Chapman and Hall,1990
2 Clark and Varney, Physical metallurgy for Engineers, Van Nostrand,1964
3. Reed Hill E. Robert, Physical metallurgy principles, 4th Edn. Cengage Learning,2009
4. Avner H Sidney, Introduction to Physical Metallurgy, Tata McGraw Hill,2009
5. Callister William. D., Material Science and Engineering, John Wiley,2014
6. Dieter George E, Mechanical Metallurgy,Tata McGraw Hill,1976
7. Higgins R.A. - Engineering Metallurgy part - I – ELBS,1998
8. Myers Marc and Krishna Kumar Chawla, Mechanical behavior of materials, Cambridge University press,2008
9. Van Vlack -Elements of Material Science - Addison Wesley,1989
10. http://nptel.ac.in/courses/113106032/1
11. http://www.myopencourses.com/subject/principles-of-physical-metallurgy-2
12. http://ocw.mit.edu/courses/materials-science-and-engineering/3-091sc-introduction-to-

solid-state-chemistry-fall-2010/syllabus/
13. http://www.msm.cam.ac.uk/teaching/partIA.php

Course Plan

Module	Contents	Hours	Semester Exam. Marks
I	Earlier and present development of atomic structure; attributes of ionization energy and conductivity, electronegativity and alloying; correlation of atomic radius to strength; electron configurations; electronic repulsion Primary bonds: - characteristics of covalent, ionic and metallic bond: attributes of bond energy, cohesive force, density, directional and non-directional and ductility. properties based on atomic bonding:- attributes of deeper energy well and shallow energy well to melting temperature, coefficient of thermal expansion - attributes of modulus of elasticity in metal cutting process -Secondary bonds:- classification- hydrogen bond and anomalous behavior of ice float on water, application- atomic mass unit and specific heat, application. *(brief review only, no University questions and internal assessment from these portions).*	2	**15%**
	Crystallography:- Crystal, space lattice, unit cell- BCC, FCC, HCP structures - short and long range order - effects of crystalline and amorphous structure on mechanical properties.	1	
	Coordination number and radius ratio; theoretical density; simple problems - Polymorphism and allotropy.	1	
	Miller Indices: - crystal plane and direction *(brief review)* - Attributes of miller indices for slip system, brittleness of BCC, HCP and ductility of FCC - Modes of plastic deformation: - Slip and twinning.	1	
	Schmid's law, equation, critical resolved shear stress, correlation of slip system with plastic deformation in metals and applications.	1	
II	Mechanism of crystallization: Homogeneous and heterogeneous nuclei formation, under cooling, dendritic growth, grain boundary irregularity.	1	**15%**
	Effects of grain size, grain size distribution, grain shape, grain orientation on dislocation/strength and creep resistance - Hall - Petch theory, simple problems	1	
	Classification of crystal imperfections: - types of dislocation – effect of point defects on mechanical properties - forest of dislocation, role of surface defects on crack initiation.	1	

	Burgers vector –dislocation source, significance of Frank Read source in metals deformation - Correlation of dislocation density with strength and nano concept, applications.	1	
	Significance high and low angle grain boundaries on dislocation – driving force for grain growth and applications during heat treatment.	1	
	Polishing and etching to determine the microstructure and grain size.	1	
	Fundamentals and crystal structure determination by X – ray diffraction, simple problems –SEM and TEM.	1	
	Diffusion in solids, Fick's laws, mechanisms, applications of diffusion in mechanical engineering, simple problems.	1	
	FIRST INTERNAL EXAMINATION		
III	Phase diagrams: - Limitations of pure metals and need of alloying - classification of alloys, solid solutions, Hume Rothery`s rule - equilibrium diagram of common types of binary systems: five types.	2	**15%**
	Coring - lever rule and Gibb`s phase rule - Reactions: - monotectic, eutectic, eutectoid, peritectic, peritectoid.	1	
	Detailed discussion on Iron-Carbon equilibrium diagram with microstructure and properties changes in austenite, ledeburite, ferrite, cementite, special features of martensite transformation, bainite, spheroidite etc.	1	
	Heat treatment: - Definition and necessity – TTT for a eutectoid iron–carbon alloy, CCT diagram, applications - annealing, normalizing, hardening, spheroidizing.	1	
	Tempering:- austermpering, martempering and ausforming - Comparative study on ductility and strength with structure of pearlite, bainite, spherodite, martensite, tempered martensite and ausforming.	1	
	Hardenability, Jominy end quench test, applications- Surface hardening methods:- no change in surface composition methods :- Flame, induction, laser and electron beam hardening processes- change in surface composition methods :carburizing and Nitriding; applications.	2	

	Types of Strengthening mechanisms: - work hardening, equation - precipitation strengthening and over ageing- dispersion hardening.	1	
	Cold working: Detailed discussion on strain hardening; recovery; re-rystallization, effect of stored energy; re-crystallization temperature - hot working Bauschinger effect and attributes in metal forming.	1	**15%**
	Alloy steels:- Effects of alloying elements on steel: dislocation movement, polymorphic transformation temperature, alpha and beta stabilizers, formation and stability of carbides, grain growth, displacement of the eutectoid point, retardation of the transformation rates, improvement in corrosion resistance, mechanical properties	1	
IV	Nickel steels, Chromium steels etc. - Enhancement of steel properties by adding alloying elements: - Molybdenum, Nickel, Chromium, Vanadium, Tungsten, Cobalt, Silicon, Copper and Lead.	1	
	High speed steels:- Mo and W types, effect of different alloying elements in HSS	1	
	Cast irons: Classifications; grey, white, malleable and spheroidal graphite cast iron etc, composition, microstructure, properties and applications.	1	**15%**
	Principal Non ferrous Alloys: - Aluminum, Copper, Magnesium, Nickel, study of composition, properties, applications, reference shall be made to the phase diagrams whenever necessary.	1	
	SECOND INTERNAL EXAMINATION		
	Fatigue: - Stress cycles – Primary and secondary stress raisers - Characteristics of fatigue failure, fatigue tests, S-N curve.	1	
	Factors affecting fatigue strength: stress concentration, size effect, surface roughness, change in surface properties, surface residual stress.	1	
V	Ways to improve fatigue life – effect of temperature on fatigue, thermal fatigue and its applications in metal cutting	1	**20%**
	Fracture: – Brittle and ductile fracture – Griffith theory of brittle fracture – Stress concentration, stress raiser – Effect of plastic deformation on crack propagation.	1	
	transgranular, intergranular fracture - Effect of impact loading on ductile material and its application in forging, applications - Mechanism of fatigue failure.	1	

	Structural features of fatigue: - crack initiation, growth, propagation - Fracture toughness (definition only) - Ductile to brittle transition temperature (DBTT) in steels and structural changes during DBTT, applications.	1	
V1	Creep: - Creep curves – creep tests - Structural change:- deformation by slip, sub-grain formation, grain boundary sliding	1	**20%**
	Mechanism of creep deformation - threshold for creep, prevention against creep - Super plasticity: need and applications	1	
	Composites:- Need of development of composites - geometrical and spatial Characteristics of particles – classification - fiber phase: - characteristics, classifications - matrix phase:- functions – only need and characteristics of PMC, MMC, and CMC – applications of composites: aircraft applications, aerospace equipment and instrument structure, industrial applications of composites, marine applications, composites in the sporting goods industry, composite biomaterials..	2	
	Modern engineering materials: - only fundamentals, need, properties and applications of, intermetallics, maraging steel, super alloys, Titanium – introduction to nuclear materials, smart materials and bio materials.	2	
	Ceramics:-coordination number and radius ratios- AX, A_mX_p, $A_mB_mX_p$ type structures – applications.	1	

Question Paper Pattern

Total marks: 100, Time: 3 hrs

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EC234	Linear Integrated Circuits and Digital Electronics Laboratory	0-0-3--1	2016

Prerequisite: EC212 Linear integrated circuits and digital electronics

Course Objectives

- To study various digital and linear integrated circuits used in simple system configuration

List of Exercises/Experiments : (10 experiments are mandatory**)**

1. Operational Amplifiers (IC741)-Characteristics
2. Square , triangular and ramp generation using op-amps
3. Log and Antilog amplifiers.
5. Astable and monostable multivibrators using op-amps
6. Active notch filter realization using op-amps
7. Wein bridges oscillator using OpAmp
8. OpAmp Integrator and Differentiator.
9. Code converter - Binary to gray and Gray to binary.
10. Adder and Subtractor Circuits using logic IC
11. Implementation of combinational logic circuits using MUX IC
12. Design and implementation of multiplexer and demultiplexer.
13. 3-bit synchronous counter design
14. Asynchronous counter design and Mod-n counter
15. Shift registers - SISO/SIPO & PISO/PIPO
16. Ring and Johnson Counters

List of major equipment

CRO, Function generator , Single power supply , Dual power supply, Digital multimeter, Ammeter ,Voltmeter.

Expected outcome .

On completion ,the students will be able to

1. Design simple circuits like amplifiers using OP-AMPs.
2. Design waveform Generating circuits.
3. Understand Digital concepts
4. Logically explain the concepts of combinational and sequential circuits.

Text Book:

1. RamakantA.Gayakward, Op-amps and Linear Integrated Circuits, IV edition, Pearson Education, 2003 / PHI.
2. D.RoyChoudhary, SheilB.Jani, Linear Integrated Circuits, II edition, New Age, 2003.
3. M. Morris Mano, Digital Logic and Computer Design, Prentice Hall of India, 2002

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME230	FLUID MECHANICS AND MACHINES LABORATORY	0-0-3-1	2016

Prerequisite: ME203 Mechanics of fluids

Course Objectives: The main objectives of this course is to demonstrate the applications of theories of basic fluid mechanics and hydraulic machines and to provide a more intuitive and physical understanding of the theory.

Syllabus

Study:

1. Study of flow measuring equipments - water meters, venturi meter, orifice meter, current meter, rotameter
2. Study of gauges - pressure gauge, vacuum gauge, manometers.
3. Study of valves - stop valve, gate valve and foot valve.
4. Study of pumps – Centrifugal, Reciprocating, Rotary, Jet.
5. Study of Turbines - Impulse and reaction types.
6. Study of Hydraulic ram, accumulator etc.

List of Experiments:

1. Determination of coefficient of discharge and calibration of Notches
2. Determination of coefficient of discharge and calibration of Orifice meter
3. Determination of coefficient of discharge and calibration of Venturimeter.
4. Determination of Chezy's constant and Darcy's coefficient on pipe friction apparatus
5. Determination of hydraulic coefficients of orifices
6. Determination of metacentric height and radius of gyration of floating bodies.
7. Experiments on hydraulic ram
8. Reynolds experiment
9. Bernoulli's experiment
10. Experiment on Torque converter
11. Performance test on positive displacement pumps
12. Performance test on centrifugal pumps, determination of operating point and efficiency
13. Performance test on gear pump
14. Performance test on Impulse turbines
15. Performance test on reaction turbines (Francis and Kaplan Turbines)
16. Speed variation test on Impulse turbine
17. Determination of best guide vane opening for Reaction turbine
18. Impact of jet

Note: 12 experiments are mandatory

Expected outcome: At the end of the course the students will be able to

1. Discuss physical basis of Bernoulli's equation, and apply it in flow measurement (orifice, Nozzle and Venturi meter), and to a variety of problems
2. Determine the efficiency and plot the characteristic curves of different types of pumps and turbines.

Course code	Course Name	L-T-P - Credits	Year of Introduction
HS200	Business Economics	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To familiarize the prospective engineers with elementary Principles of Economics and Business Economics.
- To acquaint the students with tools and techniques that are useful in their profession in Business Decision Making which will enhance their employability;
- To apply business analysis to the "firm" under different market conditions;
- To apply economic models to examine current economic scenario and evaluate policy options for addressing economic issues
- To gain understanding of some Macroeconomic concepts to improve their ability to understand the business climate;
- To prepare and analyse various business tools like balance sheet, cost benefit analysis and rate of returns at an elementary level

Syllabus

Business Economics - basic concepts, tools and analysis, scarcity and choices , resource allocation, marginal analysis, opportunity costs and production possibility curve. Fundamentals of microeconomics - Demand and Supply Analysis, equilibrium, elasticity, production and production function, cost analysis, break-even analysis and markets. Basics of macroeconomics - the circular flow models, national income analysis, inflation, trade cycles, money and credit, and monetary policy. Business decisions - investment analysis, Capital Budgeting decisions, forecasting techniques and elementary Balance Sheet and taxation, business financing, international investments

Expected outcome .

A student who has undergone this course would be able to

i. make investment decisions based on capital budgeting methods in alignment with microeconomic and macroeconomic theories.
ii. able to analyse the profitability of the firm, economy of operation, determination of price under various market situations with good grasp on the effect of trade cycles in business.
iii. gain knowledge on Monetary theory, measures by RBI in controlling interest rate and emerging concepts like Bit Coin.
iv. gain knowledge of elementary accounting concepts used for preparing balance sheet and interpretation of balance sheet

Text Books

1. Geetika, Piyali Ghosh and Chodhury, *Managerial Economics*, Tata McGraw Hill, 2015
2. Gregory Mankiw, *Principles of Macroeconomics*, Cengage Learning, 2006.
3. M.Kasi Reddy and S.Saraswathi, *Economics and Financial Accounting*. Prentice Hall of India. New Delhi.

References:

1. Dornbusch, Fischer and Startz, *Macroeconomics*, McGraw Hill, 11th edition, 2010.
2. Khan M Y, *Indian Financial System*, Tata McGraw Hill, 7th edition, 2011.
3. Samuelson, *Managerial Economics*, 6th edition, Wiley
4. Snyder C and Nicholson W, *Fundamentals of Microeconomics*, Cengage Learning (India), 2010.
5. Truett, Managerial Economics: Analysis, Problems, Cases, 8th Edition, Wiley
6. Welch, *Economics: Theory and Practice* 7th Edition, Wiley
7. Uma Kapila, *Indian Economy Since Independence, 26th Edition: A Comprehensive and Critical Analysis of India's Economy*, 1947-2015
8. C Rangarajan, *Indian Economy, Essays on monetary and finance*, UBS Publishers'Distributors, 1998
9. A.Ramachandra Aryasri, *Managerial Economics and Financial Analysis,* Tata McGraw-Hill, New Delhi.
10. Dominick Salvatore, *Managerial Economics in Global Economy,* Thomas Western College Publishing, Singapore.
11. I.M .Pandey, *Financial Management*, Vikas Publishing House. New Delhi.
12. Dominick Salvatore, *Theory and Problems of Micro Economic Theory.* Tata Mac Graw-Hill, New Delhi.
13. T.N.Hajela.*Money, Banking and Public Finance.* Anne Books. New Delhi.
14. G.S.Gupta. *Macro Economics-Theory and Applications.* Tata Mac Graw- Hill, New Delhi.
15. Yogesh, Maheswari, *Management Economics* , PHI learning, NewDelhi, 2012
16. Timothy Taylor , *Principles of Economics*, 3rdedition, TEXTBOOK MEDIA.
17. Varshney and Maheshwari. *Managerial Economics*. Sultan Chand. New Delhi

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**Business Economics** and its role in managerial decision making-meaning-scope-relevance-economic problems-scarcity Vs choice (2 Hrs)-Basic concepts in economics-scarcity, choice, resource allocation- Trade-off-opportunity cost-marginal analysis- marginal utility theory, Law of diminishing marginal utility -production possibility curve (2 Hrs)	4	15%
II	**Basics of Micro Economics I** Demand and Supply analysis-equillibrium-elasticity (demand and supply) (3 Hrs.) -Production concepts-average product-marginal product-law of variable proportions- Production function-Cobb Douglas function-problems (3 Hrs.)	6	15%
FIRST INTERNAL EXAMINATION			
III	**Basics of Micro Economics II** Concept of costs-marginal, average, fixed, variable costs-cost curves-shut down point-long run and short run (3 Hrs.)- Break Even Analysis-Problem-Markets-Perfect Competition, Monopoly and Monopolistic Competition, Oligopoly-Cartel and collusion (3 Hrs.).	6	15%
IV	**Basics of Macro Economics** - Circular flow of income-two sector and multi-sector models- National Income Concepts-Measurement methods-problems-Inflation, deflation (4 Hrs.)-Trade cycles-Money-stock and flow concept-Quantity theory of money-Fischer's Equation and Cambridge Equation -velocity of circulation of money-credit control methods-SLR, CRR, Open Market Operations-Repo and Reverse Repo rate-emerging concepts in money-bit coin (4 Hrs.).	8	15%

SECOND INTERNAL EXAMINATION			
V	**Business Decisions I**-Investment analysis-Capital Budgeting-NPV, IRR, Profitability Index, ARR, Payback Period (5 Hrs.)- Business decisions under certainty-uncertainty-selection of alternatives-risk and sensitivity- cost benefit analysis-resource management (4 Hrs.).	9	20%
VI	**Business Decisions II** Balance sheet preparation-principles and interpretation-forecasting techniques (7 Hrs.)-business financing-sources of capital- Capital and money markets-international financing-FDI, FPI, FII-Basic Principles of taxation-direct tax, indirect tax-GST (2 hrs.).	9	20%
END SEMESTER EXAM			

Question Paper Pattern

Max. marks: 100, Time: 3 hours

The question paper shall consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
HS210	LIFE SKILLS	2-0-2	2016

Prerequisite : Nil

Course Objectives

- To develop communication competence in prospective engineers.
- To enable them to convey thoughts and ideas with clarity and focus.
- To develop report writing skills.
- To equip them to face interview & Group Discussion.
- To inculcate critical thinking process.
- To prepare them on problem solving skills.
- To provide symbolic, verbal, and graphical interpretations of statements in a problem description.
- To understand team dynamics & effectiveness.
- To create an awareness on Engineering Ethics and Human Values.
- To instill Moral and Social Values, Loyalty and also to learn to appreciate the rights of others.
- To learn leadership qualities and practice them.

Syllabus

Communication Skill: Introduction to Communication, The Process of Communication, Barriers to Communication, Listening Skills, Writing Skills, Technical Writing, Letter Writing, Job Application, Report Writing, Non-verbal Communication and Body Language, Interview Skills, Group Discussion, Presentation Skills, Technology-based Communication.

Critical Thinking & Problem Solving: Creativity, Lateral thinking, Critical thinking, Multiple Intelligence, Problem Solving, Six thinking hats, Mind Mapping & Analytical Thinking.

Teamwork: Groups, Teams, Group Vs Teams, Team formation process, Stages of Group, Group Dynamics, Managing Team Performance & Team Conflicts.

Ethics, Moral & Professional Values: Human Values, Civic Rights, Engineering Ethics, Engineering as Social Experimentation, Environmental Ethics, Global Issues, Code of Ethics like ASME, ASCE, IEEE.

Leadership Skills: Leadership, Levels of Leadership, Making of a leader, Types of leadership, Transactions Vs Transformational Leadership, VUCA Leaders, DART Leadership, Leadership Grid & leadership Formulation.

Expected outcome

The students will be able to

- Communicate effectively.
- Make effective presentations.
- Write different types of reports.
- Face interview & group discussion.
- Critically think on a particular problem.
- Solve problems.
- Work in Group & Teams
- Handle Engineering Ethics and Human Values.
- Become an effective leader.

Resource Book:

Life Skills for Engineers, Complied by ICT Academy of Kerala, McGraw Hill Education (India) Private Ltd., 2016

References:

- Barun K. Mitra; (2011), *"Personality Development & Soft Skills*", First Edition; Oxford Publishers.
- Kalyana; (2015) "*Soft Skill for Managers*"; First Edition; Wiley Publishing Ltd.
- Larry James (2016); "*The First Book of Life Skills*"; First Edition; Embassy Books.
- Shalini Verma (2014); *"Development of Life Skills and Professional Practice"*; First Edition; Sultan Chand (G/L) & Company
- John C. Maxwell (2014); "The 5 Levels of Leadership", Centre Street, A division of Hachette Book Group Inc.

Course Plan

Module	Contents	Hours L-T-P L	P	Sem. Exam Marks
I	Need for Effective Communication, Levels of communication; Flow of communication; Use of language in communication; Communication networks; Significance of technical communication, Types of barriers; Miscommunication; Noise; Overcoming measures, Listening as an active skill; Types of Listeners; Listening for general content; Listening to fill up information; Intensive Listening; Listening for specific information; Developing effective listening skills; Barriers to effective listening skills. **Technical Writing:** Differences between technical and literary style, Elements of style; Common Errors, **Letter Writing:** Formal, informal and demi-official letters; business letters, **Job Application**: Cover letter, Differences between bio-data, CV and Resume, **Report Writing:** Basics of Report Writing; Structure of a report; Types of reports. **Non-verbal Communication and Body Language:** Forms of non-verbal communication; Interpreting body-language cues; Kinesics; Proxemics; Chronemics; Effective use of body language **Interview Skills**: Types of Interviews; Ensuring success in job interviews; Appropriate use of non-verbal communication, **Group Discussion**: Differences between group discussion and debate; Ensuring success in group discussions, **Presentation Skills**: Oral presentation and public speaking skills; business presentations, **Technology-based Communication:** Netiquettes: effective e-mail messages; power-point presentation; enhancing editing skills using computer software.	2 3	2 4 4	See evaluation scheme

II	Need for Creativity in the 21st century, Imagination, Intuition, Experience, Sources of Creativity, Lateral Thinking, Myths of creativity Critical thinking Vs Creative thinking, Functions of Left Brain & Right brain, Convergent & Divergent Thinking, Critical reading & Multiple Intelligence. Steps in problem solving, Problem Solving Techniques, Problem Solving through Six Thinking Hats, Mind Mapping, Forced Connections. Problem Solving strategies, Analytical Thinking and quantitative reasoning expressed in written form, Numeric, symbolic, and graphic reasoning, Solving application problems.	2 2	2 2	
III	Introduction to Groups and Teams, Team Composition, Managing Team Performance, Importance of Group, Stages of Group, Group Cycle, Group thinking, getting acquainted, Clarifying expectations. Group Problem Solving, Achieving Group Consensus. Group Dynamics techniques, Group vs Team, Team Dynamics, Teams for enhancing productivity, Building & Managing Successful Virtual Teams. Managing Team Performance & Managing Conflict in Teams. Working Together in Teams, Team Decision-Making, Team Culture & Power, Team Leader Development.	3 3	2 2	
IV	Morals, Values and Ethics, Integrity, Work Ethic, Service Learning, Civic Virtue, Respect for Others, Living Peacefully. Caring, Sharing, Honesty, Courage, Valuing Time, Cooperation, Commitment, Empathy, Self-Confidence, Character Spirituality, Senses of 'Engineering Ethics', variety of moral issued, Types of inquiry, moral dilemmas, moral autonomy, Kohlberg's theory, Gilligan's theory, Consensus and controversy, Models of Professional Roles, Theories about right action, Self-interest, customs and religion, application of ethical theories. Engineering as experimentation, engineers as responsible experimenters, Codes of ethics, Balanced outlook on. The challenger case study, Multinational corporations, Environmental ethics, computer ethics,	3 3 3	2 2	

	Weapons development, engineers as managers, consulting engineers, engineers as expert witnesses and advisors, moral leadership, sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers(India), Indian Institute of Materials Management, Institution of electronics and telecommunication engineers(IETE), India, etc.	3		
V	Introduction, a framework for considering leadership, entrepreneurial and moral leadership, vision, people selection and development, cultural dimensions of leadership, style, followers, crises. Growing as a leader, turnaround leadership, gaining control, trust, managing diverse stakeholders, crisis management Implications of national culture and multicultural leadership Types of Leadership, Leadership Traits. Leadership Styles, VUCA Leadership, DART Leadership, Transactional vs Transformational Leaders, Leadership Grid, Effective Leaders, making of a Leader, Formulate Leadership	4 2 2	 2 2	
END SEMESTER EXAM				

EVALUATION SCHEME

Internal Evaluation

(Conducted by the College)

Total Marks: 100

Part – A

(To be started after completion of Module 1 and to be completed by 30th working day of the semester)

1. Group Discussion – Create groups of about 10 students each and engage them on a GD on a suitable topic for about 20 minutes. Parameters to be used for evaluation is as follows;

(i) Communication Skills – 10 marks
(ii) Subject Clarity – 10 marks
(iii) Group Dynamics - 10 marks
(iv) Behaviors & Mannerisms - 10 marks

(Marks: 40)

Part – B

(To be started from 31st working day and to be completed before 60th working day of the semester)

2. Presentation Skills – Identify a suitable topic and ask the students to prepare a presentation (preferably a power point presentation) for about 10 minutes. Parameters to be used for evaluation is as follows;

(i)	Communication Skills*	-	10 marks
(ii)	Platform Skills**	-	10 marks
(iii)	Subject Clarity/Knowledge	-	10 marks

(Marks: 30)

* Language fluency, auditability, voice modulation, rate of speech, listening, summarizes key learnings etc.

** Postures/Gestures, Smiles/Expressions, Movements, usage of floor area etc.

Part – C

(To be conducted before the termination of semester)

3. Sample Letter writing or report writing following the guidelines and procedures. Parameters to be used for evaluation is as follows;

(i)	Usage of English & Grammar	-	10 marks
(ii)	Following the format	-	10 marks
(iii)	Content clarity	-	10 marks

(Marks: 30)

External Evaluation

(Conducted by the University)

Total Marks: 50 Time: 2 hrs.

Part – A

Short Answer questions

There will be one question from each area (five questions in total). Each question should be written in about maximum of 400 words. Parameters to be used for evaluation are as follows;

(i) Content Clarity/Subject Knowledge
(ii) Presentation style
(iii) Organization of content

(Marks: 5 x 6 = 30)

Part – B

Case Study

The students will be given a case study with questions at the end the students have to analyze the case and answer the question at the end. Parameters to be used for evaluation are as follows;

(i) Analyze the case situation
(ii) Key players/characters of the case
(iii) Identification of the problem (both major & minor if exists)
(iv) Bring out alternatives
(v) Analyze each alternative against the problem
(vi) Choose the best alternative
(vii) Implement as solution
(viii) Conclusion
(ix) Answer the question at the end of the case

(Marks: 1 x 20 = 20)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR301	Linear Control Systems	3-1-0--4	2016

Prerequisite : NIL

Course Objectives

- To give knowledge on automatic control systems and their applications in designing of mechatronics system.
- To provide knowledge about the stability analysis of control systems.
- To impart knowledge on the Mathematical modelling and analogy of different systems.

Syllabus

Principle of Automatic control- Open loop and closed loop systems- block diagram reduction - signal flow graphs - Mason's gain formula- Modeling of translational and rotational mechanical systems- force voltage & force-current analogy - toque-voltage & torque-current analogy- Time domain analysis- time domain specifications- Concept of stability- Routh-Hurwitz stability criterion- Root Locus Method- Frequency Domain Analysis- polar and Bode Plots- Nyquist Stability Criterion- PI, PD and PID controllers- Lead, Lag and Lead- Lag compensation-Case study of automatic control system.

Expected outcome.

The students will be able to

- Understand the system modeling and analogous circuits.
- Understand the concept of stability analysis in control systems using different plots
- Get knowledge in P, PI and PID controllers and compensation in control systems.
- Get knowledge in time domain analysis.
- Get knowledge on the role of control system in mechatronics with suitable case studies.

Text Book:

1. Nagrath & Gopal, *Control Systems Engineering*, New Age International (P) Limited
2. Katsuhiko Ogata, *Modem Control Engineering*, Pearson Education.
3. A. Nagoorkani, *Control Systems*, RBA Publications

References:

1. Kuo, *Automatic Control Systems*, Prentice Hall
2. Norman S. Nise, *Control Systems Engineering*, Wiley India Pvt. Ltd.
3. S. Palani, *Control Systems Engineering*, Tata McGraw Hill
4. K. Ogata, *Discrete- Time Control Systems*, Pearson Education
5. A. Anand Kumar, *Control Systems*, PHI

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Principle of Automatic control- Open loop and closed loop systems – examples System modeling & approximations - modeling of electrical systems – dynamic equations using KCL & KVL of RL, RC and RLC circuits - development of block diagrams of electrical networks - block diagram reduction - signal flow graphs - Mason's gain formula.	9	15%

II	Modeling of translational and rotational mechanical systems – differential equations for mass, spring, dashpot elements - D'Alembert's principle – dynamic equations & transfer function for typical mechanical systems - analogous systems – force voltage & force-current analogy - toque-voltage & torque-current analogy – electromechanical systems - transfer function of armature controlled dc motor & field controlled dc motor.	9	15%
FIRST INTERNAL EXAMINATION			
III	Time domain analysis – continuous systems -standard test signals - step, ramp, parabolic, impulse - transient and steady state response –first order systems - unit impulse, step & ramp responses of first order systems - second order systems -- unit step response- under damped and over damped systems - time domain specifications - steady state error – static position, velocity & acceleration error constants.	9	15%
IV	Concept of stability - stability & location of the poles in S-plane - Routh-Hurwitz stability criterion-Root Locus Method-Construction of root locus- Effect of poles and zeros and their location on the root locus.	10	15%
SECOND INTERNAL EXAMINATION			
V	Frequency Domain Analysis- Frequency Response representation- Polar Plot- Logarithmic Plots-Frequency Domain Specifications - Non-Minimum Phase Systems-Transportation	9	20%
VI	Need for Cascade compensation-Cascade Compensation- PI, PD and PID controllers – tuning of PID Controller- Lead, Lag and Lead- Lag compensation- Role of control system in mechatronics-case studies Automatic temperature control-automatic traffic light control-Automatic street light control.	10	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS

8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS

5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions

(3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS

4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions

(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR303	Microprocessors and Microcontrollers	3-0-0--3	2016

Prerequisite : NIL

Course Objectives

- To study the Architecture of microprocessor 8086 & microcontroller 8051
- To study the addressing modes & instruction set of 8086 & 8051.
- To introduce the need & use of Interrupt structure 8086 & 8051.

Syllabus

Architecture of Intel 8086 processor – Pin description –8086 configurations: Minimum mode and Maximum mode –Timing diagrams – DMA-8086 Addressing modes – Instruction set- Programmable Peripheral interface (8255) – Mode 0,1,2 operations- Interval timer application 8253- programmable interrupt controller 8259- Programmable communication Interface (8251)- DMA Controller 8237-Introduction to embedded controllers- architectures- introduction to 8051- 8051 family architecture of 8051 -pin details- port operation- memory organization- SFRs- programming in assembly - assembler directives- addressing modes- instruction set- timer and counter operations- interrupts- serial communication- introduction to hardware interfacing- programmable I/O 8255- external memory- seven segment display- LCD- stepper motor- DAC- ADC- matrix keyboard **.**

Expected outcome .

Student will gain knowledge on microprocessor and microcontrollers based system design

Text Book:

1. A.K. Roy, K.M. Bhurchandi, *Advanced Microprocessors and Peripherals* McGraw- Hill International
2. Muhammad Ali Mazidi, Janice Gillipse Mazidi, Rolin D. Mckinlay, *"8051 Microcontroller and Embedded Systems Using Assembly and C"* Pearson Education, 2010

References:

1. Douglas V Hall, *Microprocessors And Interfacing Programming and Hardware* Tata McGraw-Hill
2. N.Senthil Kumar, M.Saravanan, S.Jeevananthan, „Microprocessors and Microcontrollers", Oxford,2013.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**Architecture of 8086** Architecture of Intel 8086 processor – Pin description –8086 configurations: Minimum mode and Maximum mode –system bus timing - Timing diagrams – Interrupts: Interrupt mechanism – Types and priority – Interrupt vector table- DMA.	8	15%
II	**Programming 8086** 8086 Addressing modes – Instruction set – Data transfer Instructions – String Instructions – Logical Instructions – Arithmetic Instructions – transfer control Instructions – Processor control instructions- Arithmetic operations- Code conversion- searching –Sorting	6	15%

FIRST INTERNAL EXAMINATION			
III	**8086 interface** Programmable Peripheral interface (8255) – Mode 0,1,2 operations- Interval timer application 8253- programmable interrupt controller 8259- Programmable communication Interface (8251)- DMA Controller 8237.	8	15%
IV	**Architecture of 8051** Overview of 8051 microcontrollers – Architecture – Assembly programming –data types and directives –flag bits – register banks and stack.	6	15%
SECOND INTERNAL EXAMINATION			
V	**Programming 8051** 8051Addressing modes – Instruction set -loop and Jump instructions – call instructions – Arithmetic and Logic instructions and simple programs – 8051 interrupts – programming timer interrupts.	7	20%
VI	**8051 interface** Interfacing of microcontroller – External memory interfacing- LCD and Keyboard interfacing – Parallel and serial ADC interfacing – DAC interfacing – Interfacing 8255 - Stepper motor control – DC motor interfacing.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS

8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS

5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions

(3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS

4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions

(2 x15 = 30 marks)

Course No.	Course Name	L-T-P - Credits	Year of Introduction
MR305	PLC and Data Acquisition Systems	3-0-0--3	2016

Prerequisite : NIL

Course Objectives

- To provide students the fundamentals of PLC and Data acquisition systems

Syllabus

Need of computer in a control system-Functional block diagram of a computer control system-Data loggers- Supervisory computer control- Direct digital control-Digital control interfacing-SCADA. DACs-Basic DAC Techniques-Types of DAC - ADCs – Types of ADC-Comparison of A/D conversion techniques-DAC/ADC specifications -Isolation amplifiers. Sampling theorem – Sampling and digitizing – Aliasing – Sample and hold circuit– Definition- design and need for data acquisition systems – Interfacing ADC and DAC with Microprocessor / Multiplexer - Multiplexed channel operation –Microprocessor/PC based acquisition systems. Basics of PLC-Advantages- Capabilities of PLC- Architecture of PLC- Scan cycle- Types of PLC- Types of I/O modules- Configuring a PLC- PLC wiring-Simple process control programs using Relay Ladder Logic - PLC arithmetic functions - Timers and counters –data transfer-comparison and manipulation instructions- PID instructions- PTO / PWM generation. Requirement of communication networks of PLC – connecting PLC to computer – Interlocks and alarms Need for HMI systems. Types of HMI- interfacing PLC to HMI.

Expected outcome

- Students will understand the basics of data conversion and data acquisition systems
- Students will acquire proficiency in programming programmable logic circuits.

Text Books:

1 Curtis D. Johnson Process Control Instrumentation Tech 8TH Edition Prentice Hall June 2005.
2. Petrezeulla, Programmable Controllers, McGraw Hill , 1989.
3. D.Roy Choudhury and Shail B.Jain, Linear Integrated circuits, New age International Pvt .Ltd, 2003.
4.John W Webb & Ronald A Reis, "Programmable logic controllers: Principles and Applications", Prentice Hall India, 2003.

References:

1. G.B.Clayton, *Data Converters* The Mac Millian Press Ltd., 1982.
2. Hughes .T, *Programmable Logic Controllers*, ISA Press, 1989.
3. Bolton W. , "Mechatronics", Pearson Education, 2009
4. Prof. Rajesh Mehra, *Plcs & Scada - Theory And Practice*, Laxmi Publication

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**Computer Control -Introduction** Need of computer in a control system-Functional block diagram of a computer control system-Data loggers-Supervisory computer control- Direct digital control-Digital control interfacing-SCADA.	7	15%
II	**Data Converters** DACs-Basic DAC Techniques-Weighted Resistor- R-2R Ladder and Inverted R-2R ladder type DACs- ADCs –	7	15%

	Parallel ADC- Dual slope ADC- Successive Approximation ADC-Comparison of A/D conversion techniques- DAC/ADC specifications - Typical IC's for DAC- ADC – Isolation amplifiers.		
FIRST INTERNAL EXAMINATION			
III	**Data Acquisition Systems** Sampling theorem – Sampling and digitising – Aliasing – Sample and hold circuit– Definition- design and need for data acquisition systems – Interfacing ADC and DAC with Microprocessor / Multiplexer - Multiplexed channel operation –Microprocessor/PC based acquisition systems.	7	15%
IV	**Programmable Logic Controllers** Basics of PLC- Advantages- Capabilities of PLC- Architecture of PLC- Scan cycle- Types of PLC- Types of I/O modules- Configuring a PLC- PLC wiring.	7	15%
SECOND INTERNAL EXAMINATION			
V	**PLC Programming** Simple process control programs using Relay Ladder Logic - PLC arithmetic functions - Timers and counters –data transfer-comparison and manipulation instructions- PID instructions- PTO / PWM generation.	7	20%
VI	**PLC Communication and HMI** Requirement of communication networks of PLC – connecting PLC to computer – Interlocks and alarms HMI -Need for HMI systems- Types of HMI- interfacing PLC to HMI.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS

8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS

5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions

(3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS

4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions

(2 x15 = 30 marks)

Course No.	Course Name	L-T-P - Credits	Year of Introduction
MR307	Thermodynamics	3-0-0--3	2016

Prerequisite : NIL

Course Objectives

- To impart knowledge on the basic concepts of thermodynamics

Syllabus

Basic concepts and definitions –Zeroth law of thermodynamics – measurement of temperature- Different forms of energy- Stored energy and transition energy- work and heat- First law of thermodynamics- -Second law of thermodynamics – reversibility and irreversibility- Carnot cycle- Carnot's theorem. Entropy- Clausius' theorem- Clausius' inequality- Entropy principle and its applications- Available energy- Law of degradation of energy- useful work- dead state- Availability- Gibb's and Helmholtz function- Second law efficiency--Third law of thermodynamics. Thermodynamic relations – Maxwell's Equations- Tds equations- Joule Kelvin effect- Clausius –Clapeyron equation -Psychrometrics

Expected outcome .

- Students will gain knowledge on the concept of thermodynamics and the psychrometric properties of atmospheric air.

Text Book:

1. P.K.Nag, Thermodynamics, Tata Mc Graw Hill, 4th edition
2. Kothandaraman. C.P., Domkundwar. S. & Domkundwar. A.V., "A course in Thermal Engineering" Dhanpatrai & Co (P) Ltd, Fifth edition, 2000.

References:

1. Michael A. Boles, Yunus A. Cengel, YunusCengel, "Thermodynamics", 2nd Edition, Mc Graw Hill India, 2006.
2. Holman.J.P., "Thermodynamics", 3rd Ed. McGraw-Hill, 2000.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Basic concepts and definitions – Macroscopic and microscopic approach- Continuum concept- system and control volume- properties- processes and cycles- Method of checking of properties- Quasi-static process- homogeneous and heterogeneous systems- thermodynamic equilibrium- Zeroth law of thermodynamics – measurement of temperature- Temperature scales- Concept of absolute temperature scale.	7	15%
II	Different forms of energy- Stored energy and transition energy- work and heat- different types of work transfer- pdV work- indicator diagram- Free expansion- First law of thermodynamics- Joule's experiment-First law applied for a cycle and change of state – internal energy and enthalpy- Joule's law- PMM1	7	15%
FIRST INTERNAL EXAMINATION			
III	Second law of thermodynamics – thermal reservoir- cyclic heat engine- Kelvin – Plank and Clausius' statement- PMM2- refrigerator and heat pump- reversibility and irreversibility- Causes of irreversibility-types of irreversibility- Carnot cycle- Carnot's theorem.	7	15%

IV	Entropy- Clausius' theorem- Clausius' inequality- Entropy principle and its applications- Available energy-Law of degradation of energy- useful work- dead state- Availability- Gibb's and Helmholtz function-Second law efficiency	7	15%
SECOND INTERNAL EXAMINATION			
V	Third law of thermodynamics-Thermodynamic relations – Maxwell's Equations- Tds equations- Joule Kelvin effect- Clausius –Clapeyron equation	7	20%
VI	Psychrometrics - Properties of atmospheric air- Psychrometric properties – dry bulb temperature- wet bulb temperature and dew point temperature- specific humidity- relative humidity- degree of saturation-use of psychrometric chart- simple problems.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS

8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS

5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions

(3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS

4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions

(2 x15 = 30 marks)

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME220	MANUFACTURING TECHNOLOGY	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:-

1. To give an exposure to different techniques of casting and molds required.
2. To provide an exposure to different rolling processes and different rolled products
3. To familiarize with different forging methods, cautions to be adopted in die design.
4. To give an introduction to various work and tool holding devices used in manufacturing.
5. To introduce to the bending, shearing and drawing processes of sheet metal working and allied machines,
6. To give an understanding of welding metallurgy and weldability and to introduce various metal joining techniques.

SYLLABUS

Casting –patterns - Cores – Gating – Risering – Defects in Castings - Rolling –Defects in Rolled parts- forging – Coining – Heading – Piercing –Die Design– Extrusion Process– Extrusion Defects – Drawing Process -Principles of Location –Principles of Clamping – Types of Clamp -Sheet metal characteristics –Deep drawing –Spinning –Definition of Welding – Weldability – Solidification of Weld Metal – Heat Affected Zone – Welding Defects - Gas Welding -Arc Welding - Ultrasonic Welding – Friction Welding – Resistance Welding — Brazing- Soldering.

Expected outcomes: At the end of the course the students will be able to

1. Acquire knowledge in various casting processes and technology related to them.
2. Understand the rolling passes required for getting required shapes of rolled products.
3. Discuss important aspects of forging techniques
4. Discuss sheet metal working processes and their applications to produce various shapes and products.
5. Acquire knowledge in various types of welding processes.

Text books:-

1. Amitabha Ghosh and Ashok Kumar Mallick, Manufacturing Science Affiliated East West Press Ltd, New Delhi, 2002
2. S.Kalpakjian and Steven R Schimid, Manufacturing Engineering and Technology, Pearson,2001

Reference books:-

1. RAO, Manufacturing Technology-Vol 2 3e, McGraw Hill Education India, 2013
2. RAO, Manutacturing Technology-Vol 1 4e, McGraw Hill Education India, 2013
3. Cyril Donaldson and George H LeCain, Tool Design,TMH
4. Handbook of Fixture Design – ASTME
5. Campbell J. S., Principles of Manufacturing Materials and Processes, Tata McGraw Hill, 1999
6. P R Beeley, Foundry Technology, Elsevier, 2001
7. Richard W. Heine, Carl R. Loper, Philip C. Rosenthal, Principles of Metal Casting,

Tata McGraw-Hill Education, 2001
8. Paul Degarma E and Ronald A. Kosher ,Materials and Processes in Manufacturing, Wiley,20111
9. P. N. Rao,Manufacturing Technology Foundry, Forming and Welding, Tata McGraw-Hill Education,2011
10. HMT Production Technology, 1e McGraw Hill,2001

Course Plan			
Module	**Contents**	**Hours**	**Semester Examination Marks**
I	Sand Casting – Sand Molds-Types of Molding Sands and Testing	1	15%
	Type of patterns - Pattern Materials	1	
	Cores –Types and applications –Sand Molding Machines	1	
	Gating System – Risering	1	
	Shell Mold Casting – Ceramic Mold Casting	1	
	Investment Casting – Vacuum Casting – Slush Casting	1	
	Pressure Casting – Die Casting – Centrifugal Casting	1	
	Design Considerations based on Various Shapes - Defects in Castings – simple problems in casting	1	
II	Principles of Rolling –Types of rolling mills, Mechanics of Flat Rolling	1	15%
	Roll Force and Power Requirement - Neutral Point	1	
	Hot and Cold Rolling	1	
	Defects in Rolled Plates - Rolling Mills	1	
	Ring Rolling – Thread Rolling	1	
	Applications- Rolling of tubes, wheels, axles and I-beams	1	
FIRST INTERNAL EXAM			
III	Classification of forging – Forging methods – Forging under sticking condition	1	15%
	Precision Forging – Coining – Heading – Piercing	1	
	Die Design:- Preshaping, Design Features, Draft Angles – Die Materials and Lubrication	1	
	Forging Machines – Forging Defects and tests	1	
	Extrusion Process - Hot Extrusion – Cold Extrusion	1	
	Impact Extrusion – Extrusion Defects – Drawing Process, wire drawing process	1	

IV	Principles Location - Degrees of Freedom, 3-2-1 principle of locating	1	15%
	Locating from Planes - Locating from Circular Surfaces	1	
	Concentric Locating - Principles of Clamping	1	
	Types of Clamps - Strap Clamps Slide Clamps - Swing Clamps - Hinge Clamps	1	
	Vacuum Clamping - Magnetic Clamping	1	
SECOND INTERNAL EXAM			
V	Sheet metal characteristics – Typical shearing	1	20%
	Bending Sheet and Plate – Spingback - Bending Force	1	
	Press Brake Forming - Tube Bending	1	
	Stretch Forming - Deep Drawing	1	
	Rubber forming - Spinning Shear Spinning - Tube Spinning	1	
	Definition of Welding - Weldability – Solidification of the Weld Metal	1	
	Heat Affected Zone – correlation of strength of welded joint with structure - Welding Defects	1	
VI	Gas Welding: – Flame Characteristics	1	20%
	Equipment, fluxes and filler rods	1	
	Arc Welding – Applications and Equipment	1	
	Electrodes	1	
	Shielded Metal Arc Welding – Submerged Arc Welding	1	
	GTAW – Plasma Arc Welding	1	
	Ultrasonic Welding – Friction Welding	1	
	Resistance Spot Welding	1	
	Resistance Seam Welding – Stud Welding – Percussion Welding - simple problems in welding	1	
	Brazing:- Filler Metals, Methods - Soldering:- Techniques, Types of Solders and Fluxes	1	
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR361	Reliability Engineering	3-0-0--3	2016

Prerequisite : NIL

Course Objectives

- To understand the basic principle of reliability engineering and its applications to various systems in engineering

Syllabus

Probability - Probability distributions –-central tendency and dispersion- point estimation and interval estimation- goodness of fit tests-Reliability -Failure data analysis- reliability functions- hazard functions- Availability and Maintainability -Reliability hazard models - distribution functions and reliability analysis System Reliability - Different configurations – Redundancy – m/n system – Complex systems- Standby system. Interference theory and reliability computations – Maintainability prediction – Measures of maintainability – System Availability – Replacement theory

Expected outcome .

On completion of this subject students will be able to

- Understand the various concepts of reliability and quality in the field of engineering

Text Books:

1. Naikan A.,Reliability Engineering and Life Testing, PHI, New Delhi, 2010
2. O'Connor PDT, Practical Reliability Engineering, John Wiley & Sons Ltd, Singapore, 2004

Data Book (Approved for use in the examination): Statistical Table

References:

1. Lewis, E.E., Introduction to Reliability Engineering, John Wiley & Sons, 1995.
2. Modarres, Reliability and Risk analysis, Mara Dekker Inc., 1993.
3. Kapur K.C. and Lamberson L.R., Reliability in Engineering Design, John Wiley & Sons, 1977

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**Probability** Probability: Conditional probability- Baye's theorem- Probability distributions – Normal- Lognormal-Poisson- Exponential and Weibull distributions – relationship between them and their significance -central tendency and dispersion- point estimation and interval estimation- goodness of fit tests.	7	15%
II	**Reliability** Reliability: Definitions- Importance- Quality and reliability- bath tub curve -Failure data analysis- Hazard rate- failure rate- MTTF- MTBF- reliability functions- hazard functions- Availability and Maintainability	7	15%
	FIRST INTERNAL EXAMINATION		
III	**Failure data analysis** Reliability hazard models- Parts stress model- Constant- linearly increasing and time dependent failure rates- Weibull	7	15%

	model- distribution functions and reliability analysis System Reliability: System configurations- series- parallel- mixed configurations- k out of m system- standby systems		
IV	**Reliability assessment** Different configurations – Redundancy – m/n system – Complex systems: RBD – Baye's method – Cut and tie sets – Fault Tree Analysis – Standby system.	7	15%
SECOND INTERNAL EXAMINATION			
V	**Reliability monitoring** Interference theory and reliability computations – Normal-exponential and Weibull stress – strength Distributions Life Testing – Objectives- Types - Censoring- replacement- accelerated life testing – data quantification – Temperature stress and failure rates – stress combinations	7	20%
VI	**Reliability improvement** Analysis of downtime – Repair time distribution – System MTTR – Maintainability prediction – Measures of maintainability – System Availability – Replacement theory	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS

8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS

5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions

(3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS

4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions

(2 x15 = 30 marks)

Course No.	Course Name	L-T-P - Credits	Year of Introduction
MR363	OBJECT ORIENTED PROGRAMMING	3-0-0--3	2016

Prerequisite : NIL

Course Objectives

- To understand the concepts of object-oriented programming and master OOP using C++.

Syllabus

Object oriented programming concepts - Introduction to C++ - classes – access specifiers - function and data members - default arguments - function overloading - friend functions const and volatile functions - static members -Objects - pointers and objects - constant objects – nested classes - local classes-Constructors - destructors - Operator overloading - Function and class templates - Exception handling -Inheritance - Streams and formatted I/O - I/O manipulators - file handling - random access - object serialization - namespaces - std namespace - ANSI String Objects - standard template library.

Expected outcome .

- Familiarity with the concepts of object-oriented programming and master Object Oriented Programming using C++.

Text Book:

1. B. Trivedi, "Programming with ANSI C++", Oxford University Press, 2007.

References:

1 Ira Pohl, "Object Oriented Programming using C++", Pearson Education, Second Edition Reprint2004.
2. S. B. Lippman, Josee Lajoie, Barbara E. Moo, "C++ Primer", Fourth Edition, Pearson Education,2005.
3. B. Stroustrup, "The C++ Programming language", Third edition, Pearson Education, 2004.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Object oriented programming concepts - objects - classes - methods and messages - abstraction and encapsulation - inheritance - abstract classes - polymorphism. Introduction to C++ - classes - access specifiers - function and data members - default arguments - function overloading - friend functions - const and volatile functions - static members.	7	15%
II	Objects - pointers and objects - constant objects - nested classes - local classes-Constructors - default constructor - Parameterized constructors - Constructor with dynamic allocation - copy constructor - destructors.	7	15%
	FIRST INTERNAL EXAMINATION		
III	Operator overloading - overloading through friend functions - overloading the assignment operator - type conversion - explicit constructor.	7	15%

IV	Function and class templates - Exception handling - try-catch-throw paradigm - exception specification - terminate and Unexpected functions - Uncaught exception.	7	15%
SECOND INTERNAL EXAMINATION			
V	Inheritance - public, private, and protected derivations - multiple inheritance - virtual base class - abstract class - composite objects Runtime polymorphism - virtual functions - pure virtual functions - RTTI - typeid - dynamic casting - RTTI and templates - cross casting - down casting .	7	20%
VI	Streams and formatted I/O - I/O manipulators - file handling - random access - object serialization - namespaces - std namespace - ANSI String Objects - standard template library.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions
(3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR365	Composite Materials	3-0-0 -3	2016

Prerequisite : NIL

Course Objectives

- To impart knowledge on characteristics of composites, the methods of manufacturing, methods of testing their properties and their applications.

Syllabus

Introduction to composites: Characteristics and classifications of composites – study of fibers- flake and particulate composites- Manufacturing methods: Production of various fibers – matrix materials and surface treatments – fabrication of composites – fabrication of thermosetting resin matrix composites – fabrication of thermoplastic resin matrix composites – short fiber composites – fabrication of metal matrix and ceramic matrix composites- Testing aspects of composites: Experimental characterisation of composites – uniaxial tension- compression and shear tests – determination of inter laminar fracture toughness – damage identification through non-destructive evaluation techniques – ultrasonic- acoustic emission and radiography-Special laminates: Symmetric laminates- unidirectional- cross-ply and angle-ply laminates- quasi-isotropic laminates- Recent trends in composite materials – carbon composites- Bucky Paper- Application of composite materials in aerospace- automotive- defense and industry

Expected outcome .

- The students will acquire knowledge on the characteristics and application of modern composite materials.

Text Book:

1. B. D. Agarwal, L. J. Broutman, *Analysis and Performance of Fiber Composites*, John Wiley.

References:

1. R. F. Gibson, *Principle of Composite Material Mechanics*, McGraw Hill
2. M. M. Schwartz, *Composite Materials Handbook*, McGraw Hill. Inc.
3. R. M. Jones, *Mechanics of Composite Materials*, McGraw Hill. Inc
4. S. W. Tsai, *Introduction to Composite Materials*, Technomic Publishing Company.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to composites: Characteristics and classifications of composites – study of fibers- flake and particulate composites. Manufacturing methods: Production of various fibers – matrix materials and surface treatments.	7	15%
II	Fabrication of composites – fabrication of thermosetting resin matrix composites – fabrication of thermoplastic resin matrix composites – short fiber composites – fabrication of metal matrix and ceramic matrix composites.	7	15%
	FIRST INTERNAL EXAMINATION		
III	Testing aspects of composites: Experimental characterization of composites – uniaxial tension- compression and shear tests – determination of inter-laminar fracture toughness	7	15%

IV	Damage identification through non-destructive evaluation techniques – ultrasonic- acoustic emission and radiography	7	15%
SECOND INTERNAL EXAMINATION			
V	Special laminates: Symmetric laminates- unidirectional- cross-ply and angle-ply laminates- quasi-isotropic laminates.	7	20%
VI	Recent trends in composite materials – carbon-carbon composites- Bucky Paper- Application of composite materials in aerospace- automotive- defense and industry.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions (3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME369	Tribology	3-0-0-3	2016
Prerequisite : Nil			

Course Objectives

- To provide broad based understanding of the subject „Tribology" and its technological significance
- To understand the genesis of friction, the theories/laws of sliding and rolling friction and the effect of viscosity
- To learn about consequences of wear, wear mechanisms, wear theories and analysis of wear problems
- To learn about the principles of lubrication, lubrication regimes, theories of hydrodynamic and the advanced lubrication techniques and the application of lubrications in metal working.
- To understand the importance of adhesion property in different applications and to get knowledge about different bearing materials.
- To understand the nature of engineering surfaces, their topography and learn about surface characterization techniques

Syllabus

Introduction to Tribology- Tribology in Design, Tribology in Industry, Tribological Parameters Like Friction, Wear and Lubrication, different types of lubrication techniques and applications, measurement of friction and wear -The Topography of Engineering Surface, Contact Between Surfaces, surface modification techniques- Adhesion properties, Adhesion in Magnetic Recording Systems, Types of Bearings, Comparison of Sliding and Rolling Contact Bearings.

Expected Outcome

The students will be able to

i. Understand the subject „tribology" and its technological significance.
ii. Understanding the theories/laws of sliding and rolling friction and the effect of viscosity.
iii. Get basic idea on consequences of wear, wear mechanisms, wear theories and analysis of wear problems
iv. Get an exposure to theories of hydrodynamic and the advanced lubrication techniques and the application of lubrications in metal working.
v. Gain overview of adhesion property in different applications and to get knowledge about different bearing materials
vi. Get basic idea about the nature of engineering surfaces, their topography and learn about surface characterization techniques.

Text books

1. Ernest Rabinowicz, Friction and Wear of Materials, John Wiley & sons,1995
2. I.M. Hutchings, Tribology: Friction and Wear of Engineering Materials, Butterworth-Heinemann,1992
3. Prasanta Sahoo, Engineering Tribology, PHI Learning Private Ltd, New Delhi, 2011.

Reference books

1. B. Bhushan, Introduction to Tribology, John Wiley & Sons, Inc, New York, 2002
2. B.Bhushan, B.K. Gupta, Handbook of tribology: materials, coatings and surface treatments", McGraw-Hill,1997
3. Halling J ,"Principles of Tribology", McMillan Press Ltd.,1978

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to Tribology- Tribology in Design, Tribology in Industry, Economic Aspects of Tribology	1	15%
	Tribological Parameters Like Friction, Wear and Lubrication	1	
	The Topography of Engineering Surface, Contact Between Surfaces.	2	
	Types of Bearings, Comparison of Sliding and Rolling Contact Bearings.	2	
II	Introduction, Empirical Laws of Friction, Kinds of Friction	1	15%
	Causes of Friction, Theories of Friction	1	
	Measurement of Friction	1	
	Friction of Metals, Ceramic Materials, Polymers.	2	
	Rolling Friction- Laws of Rolling Friction, Relation Between Temperature and Friction	1	
	Stick-Slip, Prevention of Stick-Slip, Consequences of Friction.	1	
FIRST INTERNAL EXAMINATION			
III	Types of Wear, Various Factors Affecting Wear	1	15%
	Theories of Wear, Wear Mechanisms	2	
	Measurement of Wear.	1	
	Wear Regime Maps, Alternative Form of Wear Equations	1	
	Lubricated and Unlubricated Wear of Metals, Materials Used in Different Wear Situations.	2	
IV	Fundamentals of Viscosity And Viscous Flow	1	15%
	Principle and Application of; Hydrodynamic Lubrication, Elastrodynamic Lubrication, Boundary and Solid Lubrication	2	
	Types of Lubricants, Properties of Lubricants	1	
	Effect of Speed and Load on Lubrication, Frictional Polymers.	1	
	Lubrication in Metal Working: Rolling, Forging, Drawing and Extrusion.	2	
SECOND INTERNAL EXAMINATION			
V	**Adhesion:** Introduction, Adhesion Effect by Surface Tension, Purely Normal Contact and Compression Plus Shear	2	20%

	Adhesion in Magnetic Recording Systems	**1**	
	Dependence of Adhesion on Material and Geometric Properties.	**1**	
	Bearing Materials: Introduction, Rolling Bearing, Fluid Film Lubricated Bearing, Dry Bearing, Bearing Constructions.	**3**	
V1	Introduction To Surface Engineering, Concept and Scope of Surface Engineering.	**1**	**20%**
	Surface Modification – Transformation Hardening, Surface Melting, Thermo chemical Processes	**3**	
	Surface Coating – Plating and Anoding Processes, Fusion Processes, Vapor Phase Processes.	**3**	
	Selection of Coating For Wear And Corrosion Resistance, Potential Properties and Parameters of Coating.	**1**	
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR331	Microprocessors and Microcontrollers lab	0-0-3:1	2016

Prerequisite: MR303 Microprocessors and microcontrollers

Course Objectives

- To enable students to do basic programming in the microprocessors and microcontrollers.

List of Exercises/Experiments :

8086 programming using kits / MASM(Any 6)

1. 8086 kit familiarization.
2. Basic arithmetic and Logical operations
3. Square, Square root and Cube program
4. Data transfer program
5. Programming exercise using BCD and Hexadecimal numbers
6. Programming exercise : sorting ,searching and string
7. Interfacing with A/D and D/A converters
8. Interfacing with stepper motors
9. IBM PC programming : Basic programs using DOS and BIOS interrupts

8051 programming using kits (Any 6)

1. Addition and subtraction of 8 bit numbers and 16 bit numbers
2. Multi byte addition
3. Programs on Data Transfer Instructions
4. Square, Square root and Cube program
5. 8 bit multiplication and division
6. Interfacing with A/D and D/A converters
7. Waveform generation using 8051
7. Interfacing with stepper motors
8. Parallel interfacing –LCD

Expected outcome .

On completion of the course the student will be able

1. To carry out basic arithmetic and logical calculations on 8086 and 8051 processors
2. To understand the interface of 8086 and 8051 processors with external devices
3. To understand the applications of microprocessors and microcontroller based system

Text Book:

1. A.K. Roy, K.M. Bhurchandi, *Advanced Microprocessors and Peripherals* McGraw- Hill International
2. Muhammad Ali Mazidi, Janice GillipseMazidi, Rolin D. Mckinlay, *"8051 Microcontroller and Embedded Systems Using Assembly and C"* Pearson Education, 2010

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR333	Metrology and PLC Lab	0-0-3-1	2016

Prerequisite: MR305 PLC and data acquisition systems

Course Objectives

- To provide students hands on experience on measuring instruments and PLC

List of Exercises/Experiments : (Minimum 12 experiments are mandatory)

1. Strain gauge characteristics
2. load cell characteristics
3. LVDT characteristics
4. Characteristics of thermocouples
5. Characteristics of RTD
6. Characteristics of thermostats
7. LDR and opt coupler characteristics
8. AD590 characteristics
9. Capacitive transducer characteristics
10. Study of PLC
11. Implementation of logic gates using PLC
12. Implementation of flip-flops using PLC
13. Implementation of timers and counters using PLC
14. To construct sequencer using bit logic instructions only
15. Sequential switching of motors using PLC – simulation
16. Tank level control using PLC – simulation

Expected outcome .

On completion of the course the student will be able to

i. Use different measuring devices
ii. Program PLC

Text Book:

Hughes .T, *Programmable Logic Controllers*, ISA Press, 1989

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR302	Robotics Engineering	4-0-0 -4	2016

Prerequisite : NIL

Course Objectives

- To provide basic knowledge on the concepts of robotics in the context of manufacturing industry
- To impart knowledge on robotic kinematics, machine vision, sensor system and their application in real time industry.
- To learn the principles of robot drives and controls.

Syllabus

Robotics – Introduction–Basic Structure– Classification of robot and Robotic systems –laws of robotics – robot motions – work space- precision of movement-Drives and control systems and its operation-Mechanical Components of Robots-Robot End Effectors: Types of end effectors – Mechanical grippers – Types of Gripper mechanisms — Robot end effector interface-Sensors in Robotics- Descriptions - Positions - Orientations, frames, Mappings - Changing descriptions from frame to frame. Transformation arithmetic - translations - rotations - transformations - transform equations - Introduction to manipulations – Forward Kinematics and inverse Kinematics. - Methods of Robot Programming (Quantitative treatment only) - on-line/off-line - Show and Teach - Teach Pendant - Lead and Teach- Lead Teach method – robot program as a path in space - motion interpolation - WAIT - SIGNAL - DELAY Command- Application - Machining – Welding - Assembly - Material Handling

Expected outcome

The students will

- Understand the kinematics of robots and adaptive control.
- Understand the robot actuators and controls.
- Get knowledge on sensors and selection of sensors for robotic applications.
- Get knowledge in robot cell layouts and their applications.
- Get knowledge in robot programming , artificial intelligence and machine vision.

Text Books:

1. M.P. Groover, Industrial Robotics – Technology, Programming and Applications, McGraw- Hill, USA, 1986.
2. John J.Craig , "Introduction to Robotics", Pearson, 2009.

References:

i. P.A. Janaki Raman, Robotics and Image Processing, Tata McGraw-Hill, 1991.
ii. Ramesh Jam, Rangachari Kasturi, Brain G. Schunck, Machine Vision, Tata McGraw-Hill, 1991.
iii. Arthor Critchlow, Introduction to Robotics, Macmillan, 1985.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Robotics – Introduction–Basic Structure– Classification of robot and Robotic systems –laws of robotics – robot motions – work Volume- Spatial resolution – Accuracy and Repeatability of Robots- wrist configurations- motion - roll - Pitch - Yaw	10	15%
II	Drives - Hydraulic motor – DC servo motors – stepper motors – operation. Mechanical Components of Robots- Power	9	15%

	transmission systems- Gear transmission. Belt drives- cables- Roller Chains- Link – Road Systems- Rotary to linear motion conversion- Rack and pinion drives- ball bearing screws- speed reducers- Harmonic drives.		
FIRST INTERNAL EXAMINATION			
III	Robot End Effectors: Types of end effectors – Mechanical grippers – Types of Gripper mechanisms – Grippers force analysis – Other types of Grippers – Vacuum cups – Magnetic Grippers – Adhesive Grippers – Robot end effector interface.	9	15%
IV	Sensors in Robotics: Position sensors – Potentiometers- encoders – LVDT- Velocity sensors- Acceleration Sensors- Force- Pressure and Torque sensors- Touch and Tactile sensors- Proximity- Range and sniff sensors- RCC- VOICE recognition and synthesizers- contact and non contact sensors.	9	15%
SECOND INTERNAL EXAMINATION			
V	Descriptions - Positions - Orientations- frames- Mappings - Changing descriptions from frame to frame. Transformation arithmetic - translations - rotations - transformations - transform equations - transformation of free vectors. Introduction to manipulations – Forward Kinematics and inverse Kinematics.	10	20%
VI	Methods of Robot Programming (Quantitative treatment only) - on-line/off-line - Show and Teach - Teach Pendant - Lead and Teach.. Lead Teach method – robot program as a path in space - motion interpolation - WAIT - SIGNAL - DELAY Commands Application - Machining – Welding - Assembly - Material Handling - Loading and Unloading in hostile and remote environment.	9	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions (3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR304	Digital Image Processing and Machine Vision	3-0-0-3	2016

Prerequisite : NIL

Course Objectives

- To give the fundamentals of image processing and mathematical transforms necessary for image processing.
- To familiarise the image enhancement techniques.
- To know image restoration and image compression procedures.
- To provide the concept of image segmentation and image representation techniques.

Syllabus

Elements of visual perception – Image sampling and quantization- Basic relationship between pixels – Basic geometric transformations- FFT – Separable Image Transforms -Walsh – Hadamard – DCT- Haar-Spatial Domain methods: Basic grey level transformation – Histogram equalization – Image subtraction – Image averaging –Spatial filtering: Smoothing- sharpening filters –Frequency domain filters- Homomorphic filtering- Model of Image Degradation/restoration process – Noise models – Inverse filtering –Least mean square filtering – Constrained least mean square filtering – Blind image restoration – Pseudo inverse-Lossless compression: Variable length coding - predictive coding-DPCM. Lossy Compression: Transform coding – Wavelet coding – Basics of Image compression standards: JPEG- MPEG- Edge detection – Thresholding - Region Based segmentation – Boundary representation: chain codes– Boundary segments – boundary descriptors: Simple descriptors-Fourier descriptors - Regional descriptors –Simple descriptors- Texture.- Machine Vision- sensing- low and higher level vision- image acquisition and digitization- cameras- CCD- CID- CPD- illumination and types- image processing and analysis- feature extraction- applications.

Expected outcome

On completion of the course the student will be able to understand

- Basic concepts of digital image processing
- Various steps involved in digital image processing
- Techniques involved in machine vision

Text Books:

1.. Rafel C.Gonzalez and Richard E.Woods. Digital Image Processing, Addison Wesley, 1993.
2. Anil K. Jain, Fundamentals of Digital Image Processing, Prentice Hall of India, 1997
3. Vernon D, Machine Vision – Automated Visual Inspection and Robot Vision, Prentice Hall, International Ltd., 1991
4. Ramesh Jain, Rangachar Kasturi, Brain G. Schunk, Machine Vision, McGraw Hill International Editions, Computer Science Series.

References:

1. William K. Pratt, Digital Image Processing, John Wiley, NY, 1987.
2. Sid Ahmed M.A., Image Processing Theory, Algorithms and Architectures, McGraw Hill, 1995.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Elements of visual perception – Image sampling and quantization- Basic relationship between pixels – Basic	7	15%

	geometric transformations-Introduction to Fourier Transform Properties of 2D Fourier Transform – Separable Image Transforms –Walsh – Discrete Cosine Transform- Haar		
II	Spatial Domain methods: Basic grey level transformation – Histogram equalization – Image subtraction – Image averaging –Spatial filtering: Smoothing- sharpening filters –Frequency domain filters: Smoothing – Sharpening filters – Homomorphic filtering.	7	15%
FIRST INTERNAL EXAMINATION			
III	Model of Image Degradation/restoration process – Noise models – Inverse filtering –Least mean square filtering – Constrained least mean square filtering – Blind image restoration – Pseudo inverse	7	15%
IV	Lossless compression: Variable length coding – LZW coding – Bit plane coding- predictive coding-DPCM. Lossy Compression: Wavelet coding-Digital Image Watermarking. – Basics of Image compression standards: JPEG- MPEG	7	15%
SECOND INTERNAL EXAMINATION			
V	Edge detection – Thresholding - Region Based segmentation – Boundary representation: chain codes– Boundary segments – boundary descriptors: Simple descriptors-Fourier descriptors - Regional descriptors –Simple descriptors- Texture.	7	20%
VI	Machine Vision- sensing- low and higher level vision- image acquisition and digitization- cameras- CCD- CID- CPD- illumination and types- image processing and analysis- feature extraction- applications.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions (3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR306	Mechanics of Solids	3-0-0-3	2016

Prerequisite : NIL

Course Objectives

- To acquaint with the basic concepts of stress and deformation in solids.
- To impart knowledge on the methodologies to analyse stresses and strains in simple structural members, and to apply the results in simple design problems.

Syllabus

Simple Stress and Strain- analysis of deformable bodies – Material behavior – stress-strain diagrams.- deformation in axially loaded bars– statically indeterminate problems – principle of superposition. Elastic strain energy for uniaxial stress – Poisson's ratio – biaxial deformations – Bulk modulus - Relations between elastic constants - Torsion theory of elastic circular bars – economic cross-sections – statically indeterminate problems – shaft design for torsional load. - Axial force- shear force and bending moment - elastic curve – point of inflection -Stresses in beams- Pure bending – flexure formula for beams – section modulus - flexural rigidity - economic sections – beam of uniform strength - Shearing stress formula for beams – springs- Columns.

Expected outcome

The students will be

i. familiar with the basic concepts of stress and deformations.
ii. familiar with the methods to measure stress and deformation in engineering materials.

Text Books:

1. E. P. Popov, T. A. Balan, Engineering Mechanics of Solids, Pearson Education, New Delhi.
2. R K Bansal, Mechanics of solids, Laxmi Publications
3. P. N. Singh, P. K. Jha, Elementary Mechanics of Solids, Wiley Eastern Limited, New Delhi.

References:

1. Gere, Timoshenko, Mechanics of Materials, CBS Publishers & Distributors, New Delhi.
2. I.H. Shames, J. H. Pitarresi, Introduction to Solid Mechanics, Prentice Hall of India, New Delhi.
3. F. Beer, E. R. Johnston, J. T. DeWolf, Mechanics of Materials, Tata McGraw Hill, New Delhi
4. S. H. Crandal, N. C. Dhal, T. J. Lardner, An Introduction to the Mechanics of Solids, McGraw Hill
5. A. Pytel, F. L. Singer, Strength of Materials, Harper & Row Publishers, New York.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Simple Stress and Strain: Introduction to analysis of deformable bodies – internal forces – method of sections – assumptions and limitations. Simple stresses – stresses due to normal- shear and bearing loads – strength design of simple members. Definition of linear and shear strains- Material behavior-stress-strain diagrams.	7	15%

II	Hooke's law for linearly elastic isotropic material under axial and shear deformation – deformation in axially loaded bars– statically indeterminate problems – principle of superposition. Elastic strain energy for uniaxial stress. Definition of stress and strain at a point (introduction to stress and strain tensors and its components only) – Poisson's ratio – biaxial deformations – Bulk modulus - Relations between elastic constants.	7	15%
FIRST INTERNAL EXAMINATION			
III	Torsion: Torsion theory of elastic circular bars – assumptions and limitations – torsional rigidity – economic cross-sections – statically indeterminate problems – shaft design for torsional load.	7	15%
IV	Stresses in beams: Pure bending – flexure formula for beams – assumptions and limitations – section modulus - flexural rigidity - economic sections – beam of uniform strength. Shearing stress formula for beams – assumptions and limitations.	7	15%
SECOND INTERNAL EXAMINATION			
V	Axial force- shear force and bending moment: Diagrammatic conventions for supports and loading - axial force- shear force and bending moment in a beam – differential relations between load- shear force and bending moment - shear force and bending moment diagrams by direct and summation approach – elastic curve – point of inflection.	7	20%
VI	Types of springs- stiffness stresses and deflection in helical spring and leaf spring. Columns – Buckling and stiffness due to axial loads – Euler- Rankin and Empirical formulae for columns with different conditions.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions (3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR308	Digital Manufacturing	3-0-0 -3	2016

Prerequisite : NIL

Course Objectives

- To impart knowledge in FMS and shop floor control.
- To give knowledge in CNC machines and their programming.
- To enlighten on the working principles of various sensors in digital manufacturing.

Syllabus

Introduction to Computer Integrated Manufacturing- - classification - open loop and closed loop systems - special tool holders- Automatic tool changers. NC part programming - part programming examples. Controls in CIM- material handling in CIM- AGV- Vehicle guidance- vehicle management and safety automated storage systems- ASRS components and operations- features of ASRS- Quality control Condition monitoring of manufacturing systems – Role of sensors in manufacturing automation-operation principles of different sensors in Robotics and manufacturing – pneumatic- Light sensors– encoder- resolver- potentiometers- range- proximity – Temperature sensors -Pressure sensors –position sensors- displacement and velocity sensors. – sensors for monitoring force- vibration and noise. Acoustics emission sensors-principles and applications-concept of tool wear and its monitoring-MRP-MRPII-Shop floor control –Factory data collection systems – Automatic identification methods – Bar code technology- magnetic strips- automated data collection system – Agile manufacturing-flexible manufacturing.

Expected outcome

The students will

i. Understand the concept of FMS and shop floor control.
ii. Get knowledge on the construction and working of sensors used in robotics and digital manufacturing.
iii. Get knowledge in automatic identification methods.

Text Books:

1. Sabrie Salomon, Sensors and Control Systems in Manufacturing, McGraw Hill Int. Ed., 1994.
2. Mikell P. Groover, Automation Production System and Computer Integrated Manufacturing, Prentice Hall of India Ltd., 2001
3. Patranabis .D, Sensors and Transducers, Wheeler publishers, 1994.
4. S.R.Deb, Robotics technology and flexible automation, Tata McGraw Hill publishing Co. Ltd., 1994.

References:

1. Richard D. Klafter, Robotic Engineering, Prentice Hall of India Pvt., Ltd., 2001.
2. Julian W. Gardner, Micro Sensor MEMS and Smart Devices, John Wiley & Sons, 2001
3. Randy Frank, Understanding Smart Sensors, Artech house, USA, 1996

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to Computer Integrated Manufacturing- fundamentals of numerical control and Computer Numerical Control- advantages of NC system - classification of NC system - open loop and closed loop systems - special tool	7	15%

	holders- Automatic tool changers – Digital inspection		
II	NC part programming - manual programming - part programming examples- point to point programming and contour programming- computer aided programming concepts- post processor- program languages- APT- programming - part programming examples.	7	15%
FIRST INTERNAL EXAMINATION			
III	Controls in CIM- material handling in CIM- AGV- Vehicle guidance- vehicle management and safety automated storage systems- ASRS components and operations- features of ASRS-	7	15%
IV	Introduction – Role of sensors in manufacturing automation- operation principles of different sensors in Robotics and manufacturing – pneumatic- Light sensors– encoder- resolver- potentiometers- range- proximity- – Temperature sensors - Pressure sensors –position sensors- displacement and velocity sensors.	7	15%
SECOND INTERNAL EXAMINATION			
V	Quality control Condition monitoring of manufacturing systems-principles –sensors for monitoring force- vibration and noise. Acoustics emission sensors-principles and applications- concept of tool wear and its monitoring	7	20%
VI	MRP-MRPII-Shop floor control –Factory data collection systems – Automatic identification methods – Bar code technology- magnetic strips- automated data collection system – Agile manufacturing-flexible manufacturing	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions (3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR362	Digital Signal Processing	3-0-0:3	2016

Prerequisite : NIL

Course Objectives

- To introduce students the basics of Signals and Systems, Digital Signal Processing and DSP processors.
- To teach students on the design of digital filters and implementation of digital filters using various structures.

Syllabus

Signals and systems- Basic element of digital signal processing-Concept of continuous time and discrete time signals- Discrete time system- Anlaysis of Linear time invariant systems- Direct and inverse Z transform- Convolution and correlation. Classification of continuous and Discrete Time signal –- Classification of systems : Linear- Time invariant- Causal -Stable- Invertible systems- BIBO Stability criterion. Spectrum of discrete time signal- Discrete Time Fourier transform and its properties- Discrete Fourier Transform and its properties- Linear convolution using DFT- Fast Fourier Transform- Z-transform and its properties- Inverse Z-transform using partial fraction and residue methods. Design of analog filters using Butterworth and Chebyshev approximation- Frequency transformation- Design of digital IIR filters-Impulse Invariant and Bilinear transformation methods- Structures for IIR digital filters. Design of digital FIR filters – Fourier series- Frequency sampling and windowing methods- Structure for FIR filters- Comparison of IIR and FIR filters. Representation of Numbers in Digital System – Fixed and Floating point Numbers- Finite word length effects- Introduction to TMS320C5X

Expected outcome

After the completion of this course the students will be able to

i. understand the basic concepts of signals and systems.
ii. design and implement digital IIR and FIR filters.
iii. learn the architecture of the DSP processor.

Text Books:

1. Alan V. Oppenheim, Ronald W. Schaffer, *Discrete Time Signal Processing*, PHI, 1999.
2. John G. Proakis and Dimitris C. Manolakis, *Digital Signal Processing Principles, Algorithms and Applications*, Prentice Hall of India, 3rd edition, 1996.
3. Ramesh Babu C, *Digital Signal Processing*, Durai, Laxmi Publications, 2005

References:

1. Rabiner L. R. and C. B. Gold, *Theory and Applications of Digital Signal Processing*, Prentice Hall India, 1987.
2. Sanjit Mitra, *Digital Signal Processing – A Computer Based Approach*, Tata Mc Graw Hill, 2001.
3. 3. Ashok Ambardar, *Digital Signal processing – A modern Introduction*, Thomson Publishers 2007.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**Signals and systems**: Basic element of digital signal processing- Concept of continuous time and discrete time signals- Discrete time system- Anlaysis of Linear time invariant systems- Direct and inverse Z transform- Convolution and correlation	7	15%

II	Classification of continuous and Discrete Time signal – Periodic- Even and Odd- Energy and Power- Deterministic and Random- Complex exponential signals- Elementary signals – UNIT step- Ramp- Impulse- Classification of systems : Linear- Time invariant- Causal -Stable- Invertible systems- BIBO Stability criterion.	7	15%
FIRST INTERNAL EXAMINATION			
III	**TRANSFORMATION OF DISCRETE TIME SIGNALS** Spectrum of discrete time signal- Discrete Time Fourier transform and its properties- Discrete Fourier Transform and its properties- Linear convolution using DFT- Fast Fourier Transform- Z-transform and its properties- Inverse Z-transform using partial fraction and residue methods.	7	15%
IV	**IIR FILTERS** Design of analog filters using Butterworth and Chebyshev approximation- Frequency transformation- Design of digital IIR filters- Bilinear transformation methods.	7	15%
SECOND INTERNAL EXAMINATION			
V	**FIR FILTERS** Design of digital FIR filters – Fourier series- Frequency sampling and windowing methods- Structure for FIR filters- Comparison of IIR and FIR filters.	7	20%
VI	**FINITE WORD LENGTH EFFECTS AND DSP PROCESSOR** Representation of Numbers in Digital System – Fixed and Floating point Numbers- Finite word length effects- Introduction to TMS320C5X Processor architecture- Central processing unit- Memory- Addressing modes- Pipelining.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions (3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
HS300	Principles of Management	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To develop ability to critically analyse and evaluate a variety of management practices in the contemporary context;
- To understand and apply a variety of management and organisational theories in practice;
- To be able to mirror existing practices or to generate their own innovative management competencies, required for today's complex and global workplace;
- To be able to critically reflect on ethical theories and social responsibility ideologies to create sustainable organisations.

Syllabus

Definition, roles and functions of a manager, management and its science and art perspectives, management challenges and the concepts like, competitive advantage, entrepreneurship and innovation. Early contributors and their contributions to the field of management. Corporate Social Responsibility. Planning, Organizing, Staffing and HRD functions, Leading and Controlling. Decision making under certainty, uncertainty and risk, creative process and innovation involved in decision making.

Expected outcome.

A student who has undergone this course would be able to

i. manage people and organisations
ii. critically analyse and evaluate management theories and practices
iii. plan and make decisions for organisations
iv. do staffing and related HRD functions

Text Book:

Harold Koontz and Heinz Weihrich, *Essentials of Management*, McGraw Hill Companies, 10th Edition.

References:

1. Daft, *New era Management*, 11th Edition, Cengage Learning
2. Griffin, *Management Principles and Applications*, 10th Edition, Cengage Learning
3. Heinz Weirich, Mark V Cannice and Harold Koontz, *Management: a Global, Innovative and Entrepreneurial Perspective*, McGraw Hill Education, 14th Edition
4. Peter F Drucker, *The Practice of Management*, McGraw Hill, New York
5. Robbins and Coulter, *Management*, 13th Edition, 2016, Pearson Education

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to Management: definitions, managerial roles and functions; Science or Art perspectives- External environment- global, innovative and entrepreneurial perspectives of Management (3 Hrs.)– Managing people and organizations in the context of New Era- Managing for competitive advantage - the Challenges of Management (3 Hrs.)	6	15%

II	**Early Contributions and Ethics in Management**: Scientific Management- contributions of Taylor, Gilbreths, Human Relations approach-contributions of Mayo, McGregor's Theory, Ouchi's Theory Z (3 Hrs.) Systems Approach, the Contingency Approach, the Mckinsey 7-S Framework Corporate Social responsibility- Managerial Ethics. (3 Hrs)	6	15%
FIRST INTERNAL EXAMINATION			
III	**Planning:** Nature and importance of planning, -types of plans (3 Hrs.)- Steps in planning, Levels of planning - The Planning Process. – MBO (3 Hrs.).	6	15%
IV	**Organising for decision making:** Nature of organizing, organization levels and span of control in management Organisational design and structure –departmentation, line and staff concepts (3 Hrs.) Limitations of decision making- Evaluation and selecting from alternatives- programmed and non programmed decisions - decision under certainty, uncertainty and risk-creative process and innovation (3 Hrs.)	6	15%
SECOND INTERNAL EXAMINATION			
V	**Staffing and related HRD Functions:** definition, Empowerment, staff – delegation, decentralization and recentralisation of authority – Effective Organizing and culture-responsive organizations –Global and entrepreneurial organizing (3 Hrs.) Manager inventory chart-matching person with the job-system approach to selection (3 Hrs.) Job design-skills and personal characteristics needed in managers-selection process, techniques and instruments (3 Hrs.)	9	20%
VI	**Leading and Controlling:** Leading Vs Managing – Trait approach and Contingency approaches to leadership - Dimensions of Leadership (3 Hrs.) - Leadership Behavior and styles – Transactional and Transformational Leadership (3 Hrs.) Basic control process- control as a feedback system – Feed Forward Control – Requirements for effective control – control techniques – Overall controls and preventive controls – Global controlling (3 Hrs.)	9	20%
END SEMESTER EXAM			

Question Paper Pattern

Max. marks: 100, Time: 3 hours .
The question paper shall consist of three parts

Part A: 4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)
Part B : 4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)
Part C: 6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR364	Energy Engineering and Management	3-0-0-3	2016

Prerequisite : NIL

Course Objectives

- To study the engineering aspects of solar, wind and bio energy sources.
- To create awareness about the auditing and management techniques related to energy and technology

Syllabus

Solar energy engineering- Bio energy engineering- Wind energy engineering- Energy audit and management- Waste management- Technology management

Expected outcome.

The students will

i. be familiar with the concepts of solar energy engineering, wind energy engineering and bio energy engineering.

ii. grasp the basics of energy auditing techniques, waste management and technology management.

Text Books

1. W R Murphy, G A McKay, Energy Management , Butterworth-Heinemann Ltd
2. S.Rao & B.B.Parulekar, "Energy Technology", 4th edition, Khanna publishers, 2005.
3. Shah, Kanti L., Basics of Solid & Hazardous Waste Management Technology, Printice Hall, 2000
4. Chakraverthy A, "Biotechnology and Alternative Technologies for Utilization of Biomass or Agricultural Wastes", Oxford & IBH publishing Co, 1989.

References:

1. D. Yogi Goswami, Frank Kreith, Jan. F. Kreider, "Principles of Solar Engineering", 2nd Edition, Taylor & Francis, 2000, Indian reprint, 2003 2. Edward E. Anderson, "Fundamentals for solar energy conversion", Addison Wesley Publ. Co., 1983
2. Eastop T.D & Croft D.R, Energy Efficiency for Engineers and Technologists, Logman Scientific & Technical, ISBN-0-582-03184, 1990.
3. Reay D.A, Industrial Energy Conservation, 1stedition, Pergamon Press, 1977.
4. Wind energy Handbook, Edited by T. Burton, D. Sharpe, N. Jenkins and E. Bossanyi, John Wiley & Sons, 2001.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**SOLAR ENERGY ENGINEERING** Source of radiation – solar constant– solar charts – Measurement of diffuse- global and direct solar radiation: pyrheliometer- pyranometer- pyregeometer- net pyradiometer- sunshine recorder. **Photo-voltaic cell** – characteristics-cell arrays-power electric circuits for output of solar panels- choppers-inverters-batteries-charge regulators- Construction concepts.	7	15%
II	**BIO ENERGY ENGINEERING** Sources and Classification. Chemical composition- properties of biomass. Energy plantations .Size reduction- Briquetting- Drying- Storage and handling of biomas-Thermo chemical conversion of lignocelluloses biomass. Incineration- Processing for liquid fuel production.	7	15%

FIRST INTERNAL EXAMINATION			
III	**WIND ENERGY ENGINEERING** Measurement and instrumentation – Beau fort number -Gust parameters – wind type – power law index -Betz constant - Terrain value. Energy in wind– study of wind applicable Indian standards – Steel Tables- Structural Engineering- Grid-combination of diesel generator- Battery storage – wind turbine circuits- Wind farms— fatigue stress	7	15%
IV	**ENERGY AUDIT AND MANAGEMENT** Energy Audit -various Energy Conservation Measures in Steam -Losses in Boiler. Energy Conservation in Steam Systems - Case studies.-Organizational background desired for energy management motivation- detailed process of M&T-Thermostats- Boiler controls- proportional- differential and integral control- optimizers; compensators.	7	15%
SECOND INTERNAL EXAMINATION			
V	**WASTE MANAGEMENT** Sources- Types- Compositions- Properties Physical- Chemical and Biological - Collection - Transfer Stations – Waste minimization and recycling of Municipal Waste. -Size Reduction - Aerobic Composting - Incineration for Medical /Pharmaceutical Waste -Environmental Impacts - Environmental Effects due to Incineration.	7	20%
VI	**TECHNOLOGY MANAGEMENT** Invention- Innovation- Industrial & IPR- Patents- Copyrights- Trademarks- Design Registration- Trade Secrets- WTO- Trade-Patent Specifications- Patent Search Websites. -Technology Transfer Model- Technology Search Strategy- Dimensions of Technology Transfer- Features of Technology Package- Routes of Technology Transfer	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions (3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR366	Bio Materials	3-0-0-3	2016

Prerequisite : NIL

Course Objectives

- To study the structure and characteristics of biomaterials of synthetic and natural origin
- To give an idea on the effective uses of biomaterials

Syllabus

Structure of solid- Biomaterials- Polymers- metals- alloys- ceramics and composites- physical- chemical and mechanical aspects of bulk and surface properties of metallic -polymer and ceramic biomaterials- Biopolymers- Hard tissue replacement implant- - Heart valve implants . Artificial kidneys and livers. sutures- biomaterials for gene delivery- Hydrogel as stimuli- sensitive biomaterials- ophthalmologic implants- biomaterials for drug delivery- Blood and tissue compatibility of biomaterials and their in vitro and in vivo assessment- Tissue response to biomaterials. Importance of interfacial tissue reaction - Qualification of implant - Blood materials interaction-Mineralization and incrustation- - microbial- biofilm formation- bacterial adhesion toxicology- degradation of biomaterials in biological environments- Toxicity of biomaterials- acute and chronic toxicity studies. Implant associated infection.

Expected outcome

The student will

i. acquire knowledge on the structure of bio materials
ii. be able to prescribe biocompatible and bio functional materials to suit specific applications.

Text Books:

1. Ratner, Hoffman, Schoen Biomaterial science- an introduction to materials in medicine Academic press
2. Park .J.B. Biomaterials- science and engineering, Plenum press

References:

1. Sharma C.P, Szycher.M Blood compatible materials and devices, Technomic publishing company
2. R.M. Johnson, R.M. Mwaikambo, Tucker Biopolymers, Rapra technology

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Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Structure of solid. Review of basic concepts. Biomaterials-: Definition- classification. Polymers- metals- alloys- ceramics and composites- physical- chemical and mechanical aspects of bulk and surface properties of metallic -polymer and ceramic biomaterials.	8	15%
II	Biopolymers- definition- plant and animal biopolymers- polynucleotide- polyamides- polysaccharides- polyisoprene- lignin- polyphosphate and poly hydroxyl alkanoates.	6	15%
FIRST INTERNAL EXAMINATION			

III	Hard tissue replacement implant: orthopaedic implants (hip-knee)- dental implants- adhesives and sealants-Soft tissue replacement implant. Skin implant- burn (wound) - dressings/ synthetic skin- dialysis membranes.	7	15%
IV	Heart valve implants-Artificial kidneys and livers. sutures-biomaterials for gene delivery. Hydrogel as stimuli- sensitive biomaterials- ophthalmologic implants- biomaterials for drug delivery.	7	15%
SECOND INTERNAL EXAMINATION			
V	Blood and tissue compatibility of biomaterials and their in vitro and in vivo assessment- Tissue response to biomaterials. Importance of interfacial tissue reaction (eg. Ceramic bone tissue reaction)-Qualification of implant (in vivo and in vitro) Blood materials interaction.	7	20%
VI	Mineralization and incrustation- - microbial- biofilm formation- bacterial adhesion toxicology- degradation of biomaterials in biological environments. toxicity of biomaterials- acute and chronic toxicity studies-Implant associated infection.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions (3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

Course code	Course name	L-T-P-Credits	Year of Introduction
AE403	BIOMEDICAL INSTRUMENTATION	3-0-0-3	2016

Prerequisite : Nil

Course objectives

- To impart knowledge of the principle of operation and design of biomedical instruments.
- To render a broad and modern account of biomedical instruments.
- To introduce idea about human physiology system

Syllabus

Electro physiology- Bioelectric potential and cardiovascular measurements- Respirator and pulmonary measurements and rehabilitation- Patient monitoring systems- Clinical Laboratory Instruments- Imaging technique & Telemetry.

Expected outcome

At the end of the semester students will

i. be able to understand about human physiology
ii. have knowledge of the principle operation and design and the background knowledge of biomedical instruments and specific applications of biomedical engineering

Text Books

1. Arumugam.M. "*Biomedical Instrumentation*", Anuradha Agencies Publishers, Kumbakonam, 2006.
2. Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer, "*Biomedical Instrumentation and Measurements*", 2nd Edition, Prentice Hall, New Delhi, 1998.

Reference Books:

1. Geddes L. A. and Baker L. E., *"Principles of Applied Biomedical Instrumentation",* 3rd Edition, John Wiley, New York, 1989.
2. John. G. Webster, *"Medical Instrumentation, Application and Design"* John Wiley, New York, 1998
3. R.S.Khandpur, *"Handbook of Biomedical Instrumentation",* Prentice Hall of India, New Delhi, 2003
4. Richard Aston, *"Principles of Bio-medical Instrumentation and Measurement*", Merril Publishing Company, New York, 1990.

Course Plan

Module	Contents	Hours	Semester Exam Marks
I	Electro physiology: Review of physiology and anatomy, resting potential, action potential, bioelectric potentials, cardiovascular dynamics, electrode theory, bipolar and uni-polar electrodes, surface electrodes, physiological transducers. Systems approach to biological systems.	7	15%
II	Bioelectric potential and cardiovascular measurements: EMG - Evoked potential response, EEG, foetal monitor. ECG phonocardiography, vector cardiograph, BP, blood flow cardiac output, plethysmography, impedance cardiology, cardiac arrhythmia's, pace makers, defibrillators.	6	15%
FIRST INTERNAL EXAMINATION			
III	Respirator and pulmonary measurements and rehabilitation:	7	15%

	Physiology of respiratory system, respiratory rate measurement, artificial respirator, oximeter, hearing aids, functional neuromuscular simulation, physiotherapy, diathermy, nerve stimulator, artificial kidney machine.		
IV	Patient monitoring systems: Intensive cardiac care, bedside and central monitoring systems, patient monitoring through bio-telemetry, implanted transmitters, telemetering multiple information. Sources of electrical hazards and safety techniques.	7	15%
SECOND INTERNAL EXAMINATION			
V	Clinical Flame photometer - spectrophotometer – Colorimeter- chromatography- Automated Biochemical analysis system - Blood Gas Analyzer: Blood pH Measurement- Measurement of Blood pCO2- Blood pO2 Measurement- Blood Cell Counters: Types and Methods of cell Counting.	7	20%
VI	Recent trends: Medical imaging, X-rays, laser applications, ultrasound scanner, echo cardiography, CT Scan MRI/NMR, cine angiogram, colour doppler systems, Holter monitoring, endoscopy.	8	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100 Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Module 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Module 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Module 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME368	Marketing Management	3-0-0-3	2016

Prerequisite : Nil

Course Objectives: :

- To introduce the concept of market and marketing
- To give idea about launching a new product
- To introduce the various marketing strategies

Syllabus:

Introduction to marketing, Social and Marketing planning, Consumer behavior, Marketing communication, Designing the message, New trends in marketing

Expected Outcomes:

The students will be able to

i. state the role and functions of marketing within a range of organizations.
ii. describe key marketing concepts, theories and techniques for analyzing a variety of marketing situations.
iii. identify and demonstrate the dynamic nature of the environment in which marketing decisions are taken
iv. synthesize ideas into a marketing plan

Text books:

1. Majumdar R., Marketing Research, Text, Applications and Case Studies, New Age International (P), 1991
2. Ramaswamy V.S. & Namkumari S, Marketing Management: Planning, Implementation and Control, Macmillan India Limited, 2002
3. Robert, Marketing Research, Prentice Hall of India,1999
4. T N Chabra and S K Grover : Marketing management, Dhanpat Rai, 2007

Reference books:

1. Kotler P, Marketing Management: Analysis, Planning, Implementation and Control, Prentice Hall of India,1993
2. Stanton W.J., Etzel M.J. & Walker B.J, Fundamentals of Marketing, McGraw Hill International Edition, 1994

COURSE PLAN

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to marketing - concept of market and marketing – marketing environment - controllable factors - factors directed by top management - factors directed by marketing - uncontrollable factors - demography, economic conditions, competition.	7	15%
II	Social and Marketing planning - marketing planning process - Boston consultancy group model - marketing mix - marketing mix variables. Developing, testing and launching of new products .	7	15%

	FIRST INTERNAL EXAMINATION		
III	Market segmentation and market targeting - introduction to segmentation - targeting and product positioning. Marketing research - need and scope - marketing research process – research objectives, developing research plan, collecting information, analysis, and findings.	**7**	**15%**
IV	Consumer behaviour - factors influencing consumer behaviour - perceived risks Product life cycle - marketing strategies for different stages of product life cycle	**6**	**15%**
SECOND INTERNAL EXAMINATION			
V	Marketing communication - marketing mix variables - steps in developing effective communication - identification of target audience - determination of communication objectives	**7**	**20%**
V1	Designing the message - selecting the communication channels - promotion mix evaluation - advertising and sales promotion - factors in advertising - sales promotion tools. New trends in marketing- Brand management - significance of branding to consumers and firms	**8**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR332	Manufacturing Engineering Lab	0-0-3-1	2016

Prerequisite : ME220 Manufacturing technology

Course Objectives

- To demonstrate specific machine tools
- To familiarise with the different manufacturing operations

LIST OF EXPERIMENTS (Any 6 Exercises)

1.Centre Lathe- 2 Exercises (4 sections)

2. Drilling Machine-1 Exercises (2 sections)

3. Milling Machine-2 Exercises (4 sections)

4. Shaping Machine-1 Exercises (2 sections)

5.Slotting Machine-1 Exercises (2 sections)

6 Grinding Machine-1 Exercises (2 sections)

7. CNC Processes Machine-1 Exercises (2 sections)

Expected outcome.

On completion of the course the student will be able to

i. Operate specific machine tools and perform simple machining operations.
ii. Develop simple CNC part programs

Text Book:

1. Sharma, P.C., *A textbook of Production Technology – Vol I and II,* S. Chand & Company Ltd., NewDelhi, 1996.
2. Rao, P.N., *Manufacturing Technology, Vol I & II,* Tata McGraw Hill Publishing Co., New Delhi, 1998.

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR334	Advanced Instrumentation Lab	0-0-3-1	2016

Prerequisite: MR205 Science of measurements

Course Objectives

- To make students familiar with the techniques for measuring process parameters and techniques in metrology.

List of Experiments

1) Measurement of pressure

   a. Calibration of Bourdon tube pressure gauge using dead weight pressure gauge tester.
   b. Calibration of strain gauge pressure cell

2) Measurement of temperature

   Non contact temperature measurement- Radiation pyrometer and infrared pyrometer- Time constant of temperature measuring device

3) Measurement of vibration

   Piezo electric Accelerometers and vibrometers

4) Measurement of torque and force

   Measurement of cutting force during turning, drilling and milling using tool force dynamometer

5) Acoustic measurement-

   Sound level meter-octave band filter- preparation of noise Contours

6) Measurement of rotation speed

   Measurement of rotation speed using tachometer , tacho generator and stroboscopic tachometer – Calibration of tachometers

7) Metrology

   a. Measurement of surface finish using stylus type surface roughness measuring device
   b. Tool makers microscope- Measurement of tool wear using tool makers microscope
   c. Study and use of linear and angular measuring devices- vernier caliper, outside and inside micrometer, vernier depth gauge, vernier height gauge, feeler gauge, screw pitch gauge, sine bar, slip gauge- bevel protractor- profile projector
   d. Measurements of gears and screw threads

8) Analysis of exhaust gases and flue gases

   Analysis of exhaust gases and flue gases with the help of orsats apparatus, Gas chromatograph, paramagnetic oxygen analyser, smokemeter etc.

Expected outcome .

After completing the lab, the students will be able to

i. understand and use advanced techniques for measuring parameter like pressure, force, torque, rotation speed, temperature, vibration, noise level and emission
ii. familiarize themselves with basic measuring devices and procedures for calibration.

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR401	Advanced Automation Systems	4-0-0--4	2016

Prerequisite : NIL

Course Objectives

- To make students familiar with the automation and control technologies in modern manufacturing
- To provide knowledge on the elements of modern manufacturing systems

Syllabus

Automated production systems- Manufacturing operations- Industrial control systems-Automated Manufacturing Systems-Cellular manufacturing-Group Technology-Automated flexible manufacturing Systems- Advanced inspection systems-Lean Production systems and agile manufacturing systems.

Expected outcome .

After completing the course the students will have

i. know the functions of the elements of modern manufacturing systems
ii. know the modern philosophies of automated manufacturing and the advanced automation systems.

Text Book:

1. Mikell P Groover, Automation, Production Systems and Computer –Integrated Manufacturing, Pearson Education

References:

1. Groover , Automation , Production systems and CIM , Prentice Hall of India
2. Radhakrishnan, P Subramanian S,CAD/CAM and CIM ,Wiley Eastern
3. HMT Mechatronics, TATA Mc Graw Hill

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Production system facilities-low medium and high quantity production-Manufacturing support systems-Automation in production systems-manual labor in production systems-automaton principles and strategies-USA principle-ten strategies of Automation and Production Systems-Automation Migration strategy-manufacturing industries and products-manufacturing operations-processing and assembly operations-product /production relationships-production quantity and product variety-product and part complexity-limitations and capabilities of a manufacturing plant	10	15%
II	Elements of an automated system- power to accomplish the Automated process-program of Instructions-control systems-advanced automation functions-safety monitoring-maintenance and repair diagnostics-Error detection and Recovery-levels of automation, variables and parameters in process industries and discrete manufacturing industries-continuous and discrete control systems-computer process control-control requirements-capabilities of computer control and levels of industrial process control-computer process monitoring-direct digital control-numerical control and robotics-PLC-supervisory control-distributed control systems	10	15%

FIRST INTERNAL EXAMINATION			
III	Components of a manufacturing system-production machines-material handling system-computer control system-human resources-classification of manufacturing systems-types of operations performed-number of work stations-automation levels-part or product variety-Type I type II and type III manufacturing systems-manufacturing progress functions-learning curves	9	15%
IV	Part families-parts classification and coding-features and examples of part classification and coding systems-production flow analysis-cellular manufacturing-composite part concept-machine cell design-application of group technology-survey of industry practice-quantitative analysis in cellular manufacturing-grouping parts and machinery by rank order clustering-arranging machines in GT Cells.	9	15%
SECOND INTERNAL EXAMINATION			
V	Inspection metrology-contact and non contact inspection techniques-conventional measuring and gauging techniques-coordinate measuring machines-CMM construction-CMM operation and planning-CMM softwares-CMM applications and benefits-flexible inspection systems-inspection probes on machine tools-surface measurements-stylus instruments-machine vision-image acquisition and digitizing-image processing, digitizing analysis and interpretation- machine vision applications –non contact non optical inspection techniques.	9	20%
VI	Flexible manufacturing systems-types of FMS-FMS components-workstations-material handling and storage systems-computer control systems-human resources-FMS applications and benefits-FMS planning and implementation issues-FMS planning and design issues-FMS operational issues-lean production-agile manufacturing-market forces and agility-reorganizing the production for agility-manning relationships for agility-agility versus mass production-comparison of lean and agile manufacturing.	9	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS

8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS

5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions (3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS

4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions

(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR403	Nanotechnology	3-0-0-3	2016

Prerequisite : NIL

Course Objectives

- To provide basic knowledge of Nanotechnology and its applications
- To give an exposure on Nanomaterial and fabrication of Nanostructures

Syllabus

Introduction to nanotechnology- Nanomaterial- Quantum dots- Nanostructure fabrication methods- Preparation of nanomaterial - Characterization methods- Carbon nanotube preparation, properties and applications - Self assembly of materials- smart materials- Nano fluids- Nano composites- Nano fillers- Nano clays- Nano cluster- Nano wires-applications- Safety issues with Nano scale powders- micro and nanofabrication techniques- photo resist materials- Nano lithography- soft lithography- Introduction to MEMS- NEMS and Nano electronics- -bio-nanotechnology and Nano medicines- Nano bots- targeted drug delivery- dendrimers- Nano sensors- applications of nanotechnology

Expected outcome.

On completion of the course students will

i. be familiar with various nano fabrication methods.
ii. acquire knowledge on MEMS, NEMS,CNT, AFM, SEM,TEM etc

Text Book:

1. A.K. Bandyopdhyay, *Nanomaterials*,New age international publishers
2. Nanocomposite science and technology, Pulikel M. Ajayan, Wiley – VCH 2005
3. Nanolithography and patterning techniques in microelectronics, Davis G. Bucknall, Wood head publishing 2005.

References:

1. V.S.Muralidharan, A Subramnya, Nano science and Technology Ane books Pvt Ltd
2. Lynn E. Foster, Nanotechnology - Science, Innovations & Opportunity, Pearson, 2012
3. John Mongillo, Nano Technology Greenwood Press

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to nanotechnology-top down and bottom up Approach-Nanomaterial-effects of surface to volume ratio-Quantum dots	7	15%
II	Nano structure fabrication methods-Ball milling-CVD- solgel methods-Preparation of Nanomaterial like gold, silver, and different type of Nano oxides	7	15%
	FIRST INTERNAL EXAMINATION		
III	Characterisation methods-Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy-Carbon nanotube preparation- properties and applications of CNT	7	15%

IV	Self assembly of materials- self assembled Nano layers- smart materials- Nano fluids- Nano composites- Nano fillers- Nano clays- Nano cluster- Nano wires-applications	7	15%
SECOND INTERNAL EXAMINATION			
V	Safety issues with Nano scale powders- micro and nanofabrication techniques- photo lithography- photo resist materials- Nano lithography- soft lithography	7	20%
VI	Introduction to MEMS, NEMS and Nano electronics, bio-nanotechnology and Nano medicines, Nano bots, targeted drug delivery, dendrimers- Nano sensors- applications of nanotechnology	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS

8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS

5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions

(3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS

4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions

(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR405	Embedded Systems	3-0-0-3	2016

Prerequisite : NIL

Course Objectives

- To make students familiar with the architecture, hardware and software elements, programming models, tools for embedded system design and implementation of embedded system.
- To give students knowledge on the hardware and real time operating systems used for the embedded systems design.
- To expose students to the concepts of embedded system principles, software development tools and RTOS

Syllabus

Embedded system, Functional building block of embedded system- Characteristics- Challenges in embedded system design- Classification-SOC- Custom Single-purpose processors- Application specific instruction set processors- General-purpose processors- Standard single-purpose processors-Common memory device- Types of I/O devices - Serial devices - Parallel port devices - Sophisticated features- Development tools-S/W Architectures.

Expected outcome.

The student will be familiar with

- the concepts of embedded systems
- the basic concepts of real time Operating system design.
- the design techniques to develop software for embedded systems
- the general purpose operating systems and the real time operating systems

Text Book:

1 Rajkamal, "*Embedded Systems – Architecture, Programming and Design*", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2010.

2. Frank Vahid and Tony Givargis, *Embedded System Design: A Unified Hardware/Software Introduction*, Wiley, 2002.

3. David E.Simon, "A*n embedded software primer"*, Pearson Education Asia 2001.

References:

1. Wayne Wolf, "*Computers as Components: Principles of Embedded Computer Systems Design*", The Morgan Kaufmann Series in Computer Architecture and Design, Elsevier Publications, 2008.

2. Dainel W. Lewis, *Fundamentals of embedded software where C and assembly meet,* PHI 2002.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Embedded system- Functional building block of embedded system- Characteristics of embedded system applications- Challenges in embedded system design- Embedded system design processes	7	15%
II	Classification - Processors in the system - Other h/w units. Software components - Typical applications - Embedded systems on a chip (SoC) and use of VLSI circuits.	7	15%
FIRST INTERNAL EXAMINATION			

III	Custom Single-purpose processors : Hardware-Combinational Logic- Transistors and logic gates- Basic combinational and Sequential logic design- Custom single purpose processor design and optimization. Application specific instruction set processors- Microcontrollers- Digital signal processors	7	15%
IV	General-purpose processors: Software: Basic architecture- Datapath- Control unit- Memory- Instruction execution- Pipelining- Superscalar and VLIW architectures- Instruction set- Program and data memory space- Registers- I/O- Interrupts- Operating Systems- Standard single-purpose processors: Peripherals-some examples such as Timers-counters- Analog-digital converters.	7	15%
SECOND INTERNAL EXAMINATION			
V	Common memory devices - Memory selection - Memory map - Internal devices & I/O devices map - Direct memory access -. Types of I/O devices - Serial devices - Parallel port devices - Sophisticated features - Timer and Counting devices - Advanced serial bus & I/O - High speed Buses - Common types - Advanced Buses.	7	20%
VI	**Development tools**: Host and Target machines – linker / locators – debugging techniques. **S/W Architectures:** Round robin-round robin with interrupt – function queue scheduling- RTOS.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions
(3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR407	Autotronics	3-0-0-3	2016

Prerequisite : NIL

Course Objectives

- This course provides basic knowledge on the working of automobiles and the electrical and electronic systems in automobiles.

Syllabus

Automotive fundamentals: The engine-components-systems -Automotive sensors -Fuel injection and Ignition system –Electronic ignition system- Safety and comfort - Electric vehicles and hybrid vehicles - Vehicle Intelligence - mobile robot vision -object detection- collision warning and Avoidance system-low tire pressure warning system.

Expected outcome .

Students will

- acquire knowledge on the sensors used in vehicles
- be familiar with the various electronic controls used in automobiles
- become familiar with advanced comfort and safety systems used in automobiles

Text Book:

1. Tom Denton, Automobile electrical and electronic systems, BH Publication, Third edition. 2004

References:

1. Willium B. Ribbens, Understanding Automotive Electronics - Sixth edition Elsevier Science 2003
2. Ronald K.Jurgen, Sensors and Transducers - SAE 2003
3. Jack Erjavec, Robert Scharff, Automotive Technology - Delmar publications Inc 1992
4. Ronald K.Jurgen, Electric and Hybrid-electric vehicles - SAE 2002
5. Ichiro Masaki, Vision-based Vehicle Guidance - Springer Verlag, Newyork 1992
6. Jay Webster, Class Room Manual For Automotive Service And System - Delmer Publications Inc 1995
7. Ron Hodkinson, John Fenton, Light Weight Electric/Hybrid Vehicle Design - Read Educational and Professional Publications Ltd. 2001.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Automotive fundamentals: The engine-components-Drive train -Starting & charging systems operation- Ignition system- Suspension systems-brakes -ABS - Steering system –Adaptive Cruise Control	7	15%
II	Automotive sensors: introduction- working principle of sensors- throttle position sensors-manifold pressure sensor-mass air flow sensor-engine coolant temperature sensors-vehicle speed sensors- crankshaft position sensors-exhaust gas oxygen sensors	7	15%
FIRST INTERNAL EXAMINATION			

III	Fuel injection and Ignition system: Introduction -fuel system components-electronic fuel system-fuel injection-types-throttle body versus port injection-electronic control fuel injection-operation-different types-fuel injectors-idle speed control-continuous injection system-high pressure diesel fuel injection – multi point fuel injection system –Electronic ignition system-operation-types-Electronic spark timing control.	7	15%
IV	Safety and comfort : antilock braking system-traction control system-electric seats- mirrors and sun roofs- central locking and electric windows-cruise control-electric power steering-electronic clutch-electronic suspension system-airbags	7	15%
SECOND INTERNAL EXAMINATION			
V	Electric vehicles and hybrid vehicles: Introduction-Electric Vehicle development- system layout- basic system components-fuel cell Electric vehicle. Hybrid vehicle: series Hybrid Vehicle - parallel Hybrid Vehicle-CNG Electric hybrid vehicle.	7	20%
VI	Vehicle Intelligence: Introduction -basic structure-vision based autonomous road vehicles-architecture for dynamic vision system -features-applications. An application of mobile robot vision to a vehicle information system-object detection-collision warning and Avoidance system-low tire pressure warning system.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions
(3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR409	Micro Electro Mechanical Systems	3-0-0-3	2016

Prerequisite : NIL

Course Objectives

- To impart knowledge in micro machining techniques and Micro Electro Mechanical systems

Syllabus

Micro electro mechanical system – micro fabrication – microsystems and miniaturization- Materials for MEMS - Microsystems packaging- Micro Manufacturing Techniques - Micro-fabrication special machining - Theory of micromachining- Binder less wheel-Free form optics – Micro sensors: acoustic – Micro actuation - MEMS with micro actuators - Laws of scaling- Applications of MEMS - Future of MEMS

Expected outcome.

On completion of the course the student will be able to understand

i. the technology for fabrication of MEMS
ii. the behavior of materials used in MEMS
iii. the applications of MEMS

Text Books:

1. Tai-Ran Hsu MEMS & Microsytems Design and Manufacture, Tata McGraw-Hill publishing company Ltd.
2. N. Maluf, *an Introduction to Microelectro Mechanical Systems Engineering*, Artech House, 2000.

References:

1. V.C.Venaktesh , Precision Engineering, Tata McGraw-Hill Publishing Company Limited
2. Madou M.J., *Fundamentals of micro fabrication*, CRC Press, 1997.
3. Chang Liu, *Foundation of MEMS*, Illinois ECE Series, Pearson Prentice Hall 2006.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Micro electro mechanical system: MEMS and microsystems – evolution of microfabrication – microsystems and miniaturization- Materials for MEMS - Microsystems packaging.	7	15%
II	Micro Manufacturing Techniques: Photolithography- chemical Vapour Deposition – Physical Vapour Deposition- Etching Processes-Bulk micro manufacturing- surface micro manufacturing- LIGA process.	7	15%
FIRST INTERNAL EXAMINATION			

III	Micro-fabrication special machining: Laser beam micro machining- Electrical Discharge Machining- Ultrasonic Machining- Electro chemical Machining- Electron beam machining. Clean room-New Materials	7	15%
IV	Mechanical micromachining: Theory of micromachining-Chip formation-size effect in micromachining-microturning-micromilling- microdrilling- Precision Grinding : Partial ductile mode grinding- Binderless wheel-Free form optics.	7	15%
SECOND INTERNAL EXAMINATION			
V	Microsensors:acoustic- biomedical- chemical- optical- pressure-thermal- Microactuation : actuation using thermal forces- shape memory alloys- piezo electric crystals-electrostatic forces. MEMS with micro actuators: microgrippers - micromotors-microvalves-micropumps.	7	20%
VI	Laws of scaling- Applications of MEMS in various industries : Automobile- defence- healthcare- Aerospace- industry- Future of MEMS	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions
(3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR461	Fuzzy Logic Controllers	3-0-0-3	2016

Prerequisite : NIL

Course Objectives

- To provide students an exposure to the basics of fuzzy logic, neural networks and the applications of these concepts .

Syllabus

Fuzzy Logic – fuzzy sets and membership – Classical Relations and Fuzzy Relations - fuzzy Cartesian product and composition- Membership functions - Fuzzy to Crisp Conversions – defuzzification methods- Fuzzy Rule Based Systems – graphical techniques of inference- Fuzzy Decision Making - Fuzzy Control Systems - Artificial Neural Networks –Back propagation algorithm and its variants – Different types of learning- examples

Expected outcome

Upon completion of this course the student will

i. be familiar with fundamental of fuzzy approaches
ii. acquire knowledge on fuzzy linguistic descriptions and their analytical forms
iii. be familiar with the feature of Neural Networks, types of activation functions and their classifications

Text Books:

1. Vallum B.R and Hayagriva V.R C++, Neural networks and Fuzzy logic , BPB Publications, New Delhi , 1996
2. Timothy J. Ross, Fuzzy Logic with Engineering Applications, McGraw Hill International Editions

References:

1. Millon W.T , Sutton R.S and Werbos P.J, Neural Networks for control MIT Press 1992
2. Klir ,G.J and Yuan B.B Fuzzy sets and Fuzzy logic , Prentice Hall of India Pvt. Ltd. New Delhi 1997
3. Kosko. Neural Networks and Fuzzy systems,. Prentice hall of India Pvt. Ltd. New Delhi 1994
4. Dirankov D. Hellendoorn H, Reinfrank M ,.Introduction to Fuzzy control , Narosa Publishing House .. New Delhi 1996
5. Zurada J.M Introduction to Artificial Neural Systems Jaico Publishing House , New Delhi 1994

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Fuzzy Logic: introduction – uncertainty and imprecision – uncertainty in information – fuzzy sets and membership – chance versus ambiguity. Classical Sets and Fuzzy Sets: classical sets: operations on classical sets- properties of classical sets- mapping of classical sets to functions – fuzzy sets: fuzzy set operations- properties of fuzzy sets	7	15%
II	Classical Relations and Fuzzy Relations: Cartesian product – crisp relations: cardinality of crisp relations- properties of crisp relations – fuzzy relations: cardinality of fuzzy relations-	7	15%

	operations on fuzzy relations- properties of fuzzy relations- fuzzy Cartesian product and composition.		
FIRST INTERNAL EXAMINATION			
III	Membership Functions: features of membership functions – standard forms and boundaries – fuzzification – membership value assignments – membership function generation- Fuzzy to Crisp Conversions: lambda-cuts for fuzzy sets – lambda cuts for fuzzy relations – defuzzification methods.	7	15%
IV	Fuzzy Rule-Based Systems– graphical techniques of inference- Fuzzy Decision Making: fuzzy synthetic evaluation – fuzzy ordering – preference and consensus – multi objective decision making – fuzzy Bayesian decision method – decision making under fuzzy states and fuzzy actions.	7	15%
SECOND INTERNAL EXAMINATION			
V	Fuzzy Control Systems: review of control system theory – simple fuzzy logic controllers –general fuzzy logic controllers – special forms of fuzzy logic control system models – examples of fuzzy control system design.	7	20%
VI	Artificial Neural Networks: Introduction – history of neural networks – multilayer perceptron –Back propagation algorithm and its variants – Different types of learning- examples	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions
(3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

PART B: 10 MARK QUESTIONS
2 optional questions from each of first four modules. (4 x10 = 40 marks)

PART C: 15 MARK QUESTIONS
2 optional questions from each of last two modules. (2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR463	Bio Mechatronics	3-0-0-3	2016

Prerequisite : NIL

Course Objectives

The course enables the students to:

- understand types of sensors used in biomedical applications.
- be familiar with various equipment in bio-medical applications and the techniques of diagnosis

Syllabus

Cell structure – electrode – electrolyte interface- electrode potential- electrodes for their measurement- ECG- EEG- EMG -Basic transducer principles – Bio & Nano sensors - Input isolation- – instrument power supply- Telemetry principles – Bio telemetry-Electrocardiograph measurements – blood pressure measurement – blood flow measurement – phonocardiography – vector cardiography - Heart lung machine – artificial ventilator – Anesthetic machine – Basic ideas of CT scanner – MRI and ultrasonic scanner – Bio-telemetry – laser equipment and application – cardiac pacemaker – DC – defibrillator patient safety - electrical shock hazards- Centralized patient monitoring system- computers in medicine – basis of signal conversion and digital filtering data reduction technique – time and frequency domain technique – ECG Analysis

Expected outcome

The students will

i. gain knowledge in medical measurements.
ii. be able to select appropriate equipments for medical applications.
iii. have knowledge on diagnosis and analysis capabilities of biomedical equipments.

Text Books:

Arumugam M., "Bio Medical Instrumentation", Anuradha agencies Pub., 2002.

References:

1. Khandpur, R.S., "Handbook of Biomedical Instrumentation", TMH, 1989.
2. Geddes L.A., and Baker, L.E., Principles of Applied Bio-medical Instrumentation, 3rd Edition, John Wiley and Sons, 1995.
3. Cromwell, Weibell and Pfeiffer, Biomedical Instrumentation and Measurements, 2nd Edition, Prentice Hall of India, 1999.
4. Tompkins W.J., Biomedical Digital Signal Processing, Prentice Hall of India, 1998.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Cell structure – electrode – electrolyte interface- electrode potential- resting and action potential – electrodes for their measurement- ECG- EEG- EMG – machine description – methods of measurement – three equipment failures and trouble shooting	7	15%
II	Basic transducer principles Types – source of bioelectric potentials – resistive- inductive- capacitive- fiber-optic- photoelectric and chemical transducers – their description and feature applicable for biomedical instrumentation – Bio & Nano sensors & application	7	15%

FIRST INTERNAL EXAMINATION			
III	Input isolation- DC amplifier- power amplifier- and differential amplifier – feedback- op-Amp-electrometer amplifier- carrier Amplifier – instrument power supply- Oscillagraphic – galvanometric - X-Y- magnetic recorder- storage oscilloscopes – electron microscope – PMMC writing systems – Telemetry principles – Bio telemetry	7	15%
IV	Electrocardiograph measurements – blood pressure measurement: by ultrasonic method – plethysonography – blood flow measurement by electromagnetic flow meter cardiac output measurement by dilution method – phonocardiography – vector cardiography	7	15%
SECOND INTERNAL EXAMINATION			
V	Heart lung machine – artificial ventilator – Anesthetic machine – Basic ideas of CT scanner – MRI and ultrasonic scanner – Bio-telemetry – laser equipment and application – cardiac pacemaker – DC – defibrillator patient safety - electrical shock hazards- Centralized patient monitoring system	7	20%
VI	Introduction – computers in medicine – basis of signal conversion and digital filtering data reduction technique – time and frequency domain technique – ECG Analysis	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions
(3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR465	Entrepreneurship	3-0-0-3	2016

Prerequisite : NIL

Course Objectives

- To impart knowledge on enterprises and entrepreneurship
- To impart knowledge on the various elements in a business systems

Syllabus

Entrepreneurial perspectives- entrepreneurship and economic development- Characteristics of entrepreneur- Process of business opportunity identification and evaluation- industrial policy- Business- Environment market survey - project report preparation- Process and strategies for starting venture- entrepreneurship in international environment- achievement motivation- Time management creativity and innovation structure of the enterprise- Technology acquisition for small units- financing of project and working capital- break even analysis and economic ratios technology transfer and business

Expected outcome

On completion of this subject students will

i. acquire knowledge on the techno economic feasibility assessment procedure .
ii. be able to prepare project proposals
iii. Know the various forms of finance and support available for entrepreneurs.

Text Books:

1. Pandey G.W., A complete Guide to successful Entrepreneurship, Vikas Publishing
2. Harold Koontz & Heinz Weihrich, Essentials of Management, McGraw hill International

References:

1. Hirich R.D. &Peters Irwin M.P., Entrepreneurship, McGraw Hill
2. Rao T V, Deshpande M V, Prayag Mehta & Manohar S Nadakarni, Developing Entrepreneurship a Hand Book, Learning systems

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Entrepreneurial perspectives- understanding of entrepreneurship process- entrepreneurial decision process- entrepreneurship and economic development	7	15%
II	Characteristics of entrepreneur- entrepreneurial competencies- managerial functions for enterprise- Process of business opportunity identification and evaluation- industrial policy	7	15%
FIRST INTERNAL EXAMINATION			

III	Business- Environment market survey - project report preparation-study of feasibility and viability of a project assessment of risk in the industry	7	15%
IV	Process and strategies for starting venture- stages of small business growth- entrepreneurship in international environment- entrepreneurship- achievement motivation	7	15%
SECOND INTERNAL EXAMINATION			
V	Time management creativity and innovation structure of the enterprise- planning, implementation and growth- Technology acquisition for small units	7	20%
VI	Formalities to be completed for setting up a small scale uniforms of organizations for small scale units-financing of project and working capital-venture capital and other equity assistance available- break even analysis and economic ratios technology transfer and business	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions
(3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME469	FINITE ELEMENT ANALYSIS	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

1. To learn the mathematical background of finite element methods.
2. To understand the basics of finite element formulation.
3. To practice finite element methodologies through structural and heat transfer problems.

Syllabus

Introduction; Brief history; Review of elasticity; Direct approach;1D bar element; Analogous problems; Beam elements; Plane truss; Coordinate transformations; Interpolation functions; Shape functions; Variational methods; Strong and weak form; Rayleigh Ritz method; FE formulation using minimization of potential; Consistent nodal loads; Higher order elements; Iso parametric elements; Weighted residual methods; FEA software packages.

Expected outcome

The students will be able to

i. understand the mathematical background of FEM .
ii. solve real life problems using finite element analysis

Text Books:

1. Chandrupatla T R., Finite Element Analysis for Engineering and Technology, University Press, 2004
2. Hutton D V., Fundamentals of Finite Element Analysis, Tata McGraw-Hill, 2005
3. Logan D L., A first course in the Finite Element Method, Thomson-Engineering, 2012
4. Seshu P., Text Book of Finite Element Analysis, PHI Learning Pvt. Ltd., 2003

References Books:

1. Cook R D., Malkus D S., Plesha M E.,Witt R J., Concepts and Analysis of Finite Element Applications, John Wiley & Sons,1981
2. Reddy J N., An introduction to the Finite Element Method, McGraw- Hill, 2006

Course

Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to Finite Element Method (FEM)- Brief history- Application of FEA- Advantages and disadvantages. Review of elasticity- Strain displacement relations- Compatibility-Stress strain relations- Boundary conditions- Plane stress, plane strain and axisymmetry.	2	15%

	Direct approach-1D bar element- element stiffness- Assembly of elements- properties of [K] matrix- Treatment of boundary conditions- Stress computation.	4	
II	Analogous problems of torsion, heat conduction and laminar pipe flow. Beam elements- FE formulation-element stiffness matrix- boundary conditions.	4	20%
	Plane truss- Element formulation-Co ordinate transformation- Local and global co ordinates- Stress calculations.	4	
FIRST INTERNAL EXAMINATION			
III	Interpolation functions-Shape functions- Lagrange interpolation- 1D linear and quadratic element	3	15%
	Variational methods: Functionals- Strong and weak form- Essential and natural boundary conditions.	3	
IV	Principle of stationary potential energy- Rayleigh Ritz method.	3	20%
	FE formulation using minimization of potential- B matrix- Element matrices for bar element- Consistent nodal loads.	4	
SECOND INTERNAL EXAMINATION			
V	Higher order elements- Quadratic and cubic elements-Pascal's triangle-Serendipity elements.	3	15%
	Iso parametric elements, Natural coordinates, Area co ordinates-Quadrilateral elements-Jacobian matrix-Gauss quadrature.	5	
VI	Weighted residual method: Galerkin FE formulation. Axially loaded bar-Heat flow in a bar	5	15%
	Structure of FEA software package. Introduction to Modal analysis, non linear analysis and coupled analysis.	2	
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100, **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR431	Mechatronics Lab	0-0-3-1	2016

Prerequisite : Nil

Course Objectives

- To provide hands on experience on the working of hydraulic and pneumatic controls, speed control, and PID controllers
- To impart proficiency in programming of robots
- To impart knowledge on virtual instrumentation and vision systems

List of Exercises/Experiments :

1. Design and assembly of pneumatic/hydraulic kit
2. Study of different type of pneumatic and hydraulic valve.
3. Study of reciprocating movement of double acting cylinder using pneumatic direction control valve.
4. Speed control stepper and servo motor using micro processor kit.
5. Programming Robot (Pick and place robot)
6. Sensors for automotives
7. Tool condition monitoring using sensors.
8. PID Controller
9. Automatic door opening and closing
10. Virtual Instrumentation
    a. Data acquisition
    b. Image acquisition
    c. Stepper and servo control device
    d. Signal conditioning of strain gauge. LVDT, Thermocouple, pressure transducer, etc.,
11. A/D and D/A conversion
12. Machine Vision system
13. Study of robot end effectors

Expected outcome.

The students will be able to

- Develop pneumatic circuits for automating various operations
- Program a robot for a pick and place operation
- Prescribe sensors for monitoring and control operations
- Acquire knowledge on analog and digital data convertors

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR402	Soft Computing Techniques	3-0-0:3	2016

Prerequisite : NIL

Course Objectives

- To introduce the concepts of fuzzy sets and fuzzy logic
- To make students familiar with neural networks that can learn from available examples

Syllabus

Introduction to Neuro – Fuzzy and Soft Computing – Fuzzy Rules and Fuzzy Reasoning – Extension Principle and Fuzzy Relations - Fuzzy Inference Systems – Fuzzy Models -Derivative-based Optimization – Genetic Algorithms – Radial Basis Function Networks – Adaptive Neuro-Fuzzy Inference Systems – Coactive Neuro Fuzzy Modeling – Framework Neuron Functions for Adaptive Networks – Neuro Fuzzy Spectrum- Printed Character Recognition – Inverse Kinematics Problems – Automobile Fuel Efficiency Prediction – Soft Computing for Color Recipe Prediction.

Expected outcome .

- The students will be familiar with the techniques of soft computing and adaptive neuro fuzzy inferencing systems and will be able to use the techniques to simulate and optimize engineering systems.

Text Book:

1. J.S.R.Jang, C.T.Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI, 2004, Pearson Education 2004.
2. S.N.Sivanandam & S.N.Deepa "Principles of Soft Computing" Wiley India Pvt. Ltd., 2007

References:

1. Timothy J.Ross, "Fuzzy Logic with Engineering Applications", McGraw-Hill, 1997.
2. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.
3. S. Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI, 2003.
4. R.Eberhart, P.Simpson and R.Dobbins, "Computational Intelligence - PC Tools", AP Professional, Boston, 1996.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to Neuro – Fuzzy and Soft Computing – Fuzzy Sets – Basic Definition and Terminology – Set-theoretic Operations – Member Function Formulation and Parameterization – Fuzzy Rules and Fuzzy Reasoning – Extension Principle and Fuzzy Relations .	7	15%
II	Fuzzy Inference Systems – Mamdani Fuzzy Models – Sugeno Fuzzy Models – Tsukamoto Fuzzy Models. Derivative-based Optimization – Descent Methods – The Method of Steepest Descent – Classical Newton's Method	7	15%

FIRST INTERNAL EXAMINATION			
III	Step Size Determination – Derivative-free Optimization – Genetic Algorithms – Simulated Annealing – Random Search – Downhill Simplex Search. Supervised Learning Neural Networks – Perceptrons - Adaline – Back propagation Mutilayer Perceptrons	7	15%
IV	Radial Basis Function Networks – Unsupervised Learning Neural Networks – Competitive Learning Networks – Kohonen Self-Organizing Networks – Learning Vector Quantization – Hebbian learning.	7	15%
SECOND INTERNAL EXAMINATION			
V	Adaptive Neuro-Fuzzy Inference Systems – Architecture – Hybrid Learning Algorithm – Learning Methods that Cross-fertilize ANFIS and RBFN – Coactive Neuro Fuzzy Modeling – Framework Neuron Functions for Adaptive Networks – Neuro Fuzzy Spectrum.	7	20%
VI	Printed Character Recognition – Inverse Kinematics Problems – Automobile Fuel Efficiency Prediction – Soft Computing for Color Recipe Prediction.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
6 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions (3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
3 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR 404	Power Electronics and Drives	3-0-0:3	2016

Prerequisite : Nil

Course Objectives

- To give an overview of different types of power semiconductor devices and their switching characteristics.
- To understand the operation, characteristics and performance parameters of controlled rectifiers.
- To study the operation, switching techniques and basic topologies of switching regulators

Syllabus

Power semi conductor devices- characteristics of power diodes- SCR- TRIAC- GTO- power BJT- power MOSFET and IGBT –- phase controlled converters-single phase full converters- 3 phase half converter and 3 phase full converter – input power factor – thyristor triggering circuits- dc to dc choppers-dc chopper – step up and step down chopper – forced commutation – different techniques – voltage- current and load – commutated choppers – inverters-voltage source inverters – series- parallel and bridge inverters – PWM inverters – current source inverters- ac voltage controllers and cyclo converters-single phase ac voltage controller – multistage sequence control – step up and step down cyclo converters –introduction to electric drives– advantages- parts of electrical drives – fundamental torque equation – four quadrant operation – components of load torque

Expected outcome .

The students will be able to

- analyse the dynamic and switching characteristics of power semiconductor devices.
- determine the performance parameters of controlled rectifiers and AC voltage controllers.
- design Choppers and Switching Regulators.
- understand the working of Fixed DC to Variable AC converters and learn the Modulation Techniques employed in Inverters

Text Books:

1. Bhimbra P S, *Power Electronics,* Khanna Publishers, 2001
2. Reshid M.H., Power Electronics – Circuits Devices and Application, Prentice Hall International, New Delhi, 3rd Edition, 2004

References:

1. Dubey, G.K., Doradia, S.R., Joshi, A. and Singh, R.M., Thyristorised Power Controllers, Wiley Eastern Limited, 1986.
2. Joseph Vithayathil, Power Electronics – Principle and Applications, and Robbins, McGraw-Hill Inc, New York, 1995.
3. Lander, W., Power Electronics, McGraw-Hill and Company, 3rd Edition, 1993.
4. Mohan Undeland and Robbins, Power Electronics, John Wiley and Sons, New York, 1995
5. Singh, M.D., Khanchandani, K.B., Power Electronics, Tata McGraw-Hill, 1998.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**POWER SEMI CONDUCTOR DEVICES** Principle of operation – Characteristics of power diodes- SCR- TRIAC- GTO- Power BJT- Power MOSFET and IGBT – Thyristor protection circuits.	7	15%

II	**PHASE CONTROLLED CONVERTERS** Single phase full converters- 3 phase half converter and 3 phase full converter – inverter operation – input power factor – effect of source inductance – Thyristor triggering circuits.	7	15%
FIRST INTERNAL EXAMINATION			
III	**DC TO DC CHOPPERS** DC Chopper – Principle of operation – step up and step down chopper – Forced commutation – different techniques – voltage- current and load – commutated choppers – step up and step down chopper.	7	15%
IV	**INVERTERS** Voltage source inverters – series- parallel and bridge inverters – PWM inverters – current source inverters.	7	15%
SECOND INTERNAL EXAMINATION			
V	**AC VOLTAGE CONTROLLERS AND CYCLOCONVERTERS** Single phase AC voltage controller – multistage sequence control – step up and step down cyclo converters – three phase to single phase and three phase cyclo converters.	7	20%
VI	**INTRODUCTION TO ELECTRIC DRIVES** Electrical Drives – advantages of electric drives - parts of electrical drives – fundamental torque equation – four quadrant operation – components of load torque - friction- windage & load torques – steady state stability	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions (3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR462	Industrial Electronics and Applications	3-0-0:3	2016

Prerequisite : NIL

Course Objectives

- To introduce the application of electronic devices for conversion control and conditioning of electric power in industrial environment

Syllabus

Concept of thyristor technology- turn on methods and turn off methods of thyristors- diacs- SCS- SVS SBS- LASCR- Traics and MOSFETS-IGBT-IGCT- Concept of regulation- Principles of series and shunt regulators- Three terminal voltage regulator ICs - Concepts of CV- CC and foldback limiting- short circuit and overload protection – Major specifications of a regulated power supply and their significance-- switched mode power supply –floating and grounded power supplies -Fly back converter-UPS-dual tracking power supply- Resistance heating- Induction heating- Electronic heaters employed for Induction heating- Thyristorised supplies used in Induction Furnances- Dielectric heating- Electric Welding- Switching circuits – Automatic battery charger – Emergency light – Time delay relay circuit – Fan Speed control – Temperature control – Speed control of Dc and small DC motors – Speed control of DC shunt motor using thyristor technology – Over-voltage protection and over load protection of DC motors- Speed control of single phase induction motor- three phase induction motor- and universal series motor- Traic as a starter for single phase induction motors.

Expected outcome .

The students will be able to

- Understand the use of Basic electronic devices, their circuits and applications to bring about faster and more accurate responses in industrial installations.

Text Books:

1. P.C Sen , Power electronics , , Tata McGraw Hill 2008
2. S K Bhattacharya, S Chattertji; *Industrial electronics and control*, Tata McGraw Hill New Delhi.

References:

1. G K Mithal , Industrial Electronics, , Khanna Publishers, New Delhi-1994
2. Noel Morris , Industrial Electronics, , TMH, New Delhi 1999
3. T.E Kissel , Industrial Electronics, , PHI learning, New Delhi 2011

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Concept of thyristor technology- ratings- symbol- characteristics- turn on methods and turn off methods of thyristors- diacs- SCS- SVS SBS- LASCR- Traics and MOSFETS-IGBT-IGCT	7	15%
II	Concept of regulation- Principles of series and shunt regulators- Three terminal voltage regulator ICs (positive- negative and variable applications)- Concepts of CV- CC and foldback limiting- short circuit and overload protection – Major specifications of a regulated power supply and their significance (line and load regulation- output ripple and transients)	7	15%
FIRST INTERNAL EXAMINATION			

III	Basic working principles of a switched mode power supply – concept of floating and grounded power supplies and their interconnections to obtain multiple output supplies-Fly back converter-UPS-dual tracking power supply	7	15%
IV	Resistance heating- Induction heating- Electronic heaters employed for Induction heating- Thyristorised supplies used in Induction Furnances- Dielectric heating- Electric Welding	7	15%
SECOND INTERNAL EXAMINATION			
V	Principle of operation and working of following switching circuits – Automatic battery charger – Emergency light – Time delay relay circuit – Fan Speed control – Temperature control – Speed control of Dc and small DC motors – SMPS – UPS	7	20%
VI	Speed control of DC shunt motor using thyristor technology – Over-voltage protection and over load protection of DC motors- Speed control of single phase induction motor- three phase induction motor- and universal series motor- Traic as a starter for single phase induction motors	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions (3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR464	Agile Manufacturing Systems	3-0-0:3	2016

Prerequisite : NIL

Course Objectives

- To acquaint with basic concepts of agile manufacturing.
- To understand the conceptual and theoretical basis for the design and implementation of Advanced Manufacturing Systems.
- To design and evaluate the performance of agile manufacturing systems.

Syllabus

Introduction, conceptual framework, core concepts, Change Management, product costing, performance, Measurement and control systems, Agile Manufacturing Enterprise Design -Skill & Knowledge Enhancing Technologies For Agile Manufacturing, scheduling, technology design strategic, Design Concepts , Problems and Future Development.

Expected outcome .

The students will

i. understand the scope of Agile manufacturing systems.
ii. understand the concepts of designing agile manufacturing systems

Text Book:

1. Gunasekaran A, "Agile Manufacturing, 21st Strategy Competitiveness Strategy", Elsevier Publications, 2001.
2. Paul T Kidd , Concurrent Engg, Addison Wesley Publication, 1994
3. Paul T Kidd ,World Class manufacturing, Addition Wesley Pub., 1994
4. Paul T. Kidd , Agile Manufacturing -Forging new Frontiers, Addison Wesley Publication, 1994.

References:

1. Brian H Maskell, "Software and the Agile Manufacturer, Computer Systems and World Class Manufacturing, Productivity Press, 1993.
2. Goldman S L, Nagal R N and Preiss K, "Agile Competitors and Virtual Organizations", Van Nostrand Reinhold, 1995.
3. S. R. Devadasan, V. Sivakumar, R. Murugesh, P. R. Shalij; Lean and Agile manufacturing: Theoretical, practical and research futurities, PHI learning private ltd.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction: Need for agile Manufacturing -Competitive environment of the future- the business case for agile manufacturing conceptual framework for agile manufacturing	7	15%
II	Four Core Concepts: strategy driven approach- integrating organization- people technology interdisciplinary design methodology	7	15%
	FIRST INTERNAL EXAMINATION		
III	Agile Manufacturing and Change Management: The change implications- post failures in advanced manufacturing- changes	7	15%

	on the way- traditional management accounting- paradigm- investment appraisal- product costing - performance- Measurement and control systems		
IV	Control technological and Design paradigms - traditional problems in workplace- organizational issues -role of technology	7	15%
SECOND INTERNAL EXAMINATION			
V	Agile Manufacturing Enterprise Design: Agile manufacturing – enterprise design -system concepts as the basic manufacturing theory-joint technical & organizational design as a model for the design of agile manufacturing enterprise-- enterprise design process -insights into design processes	7	20%
VI	Skill & Knowledge Enhancing Technologies For Agile Manufacturing: Skill and Knowledge enhancing Technologies - scheduling -technology design strategic- Design Concepts- Historical Overview- Lessons- Problems and Future Development	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions (3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR466	Special Electrical Machines and Applications	3-0-0:3	2016

Prerequisite : NIL

Course Objectives

- To impart knowledge on the working of special electrical machines and their applications in mechatronics systems.
- To impart knowledge on the characteristics of stepper motors, synchronous motors, PMDC motors and switched reluctance motors.

Syllabus

Introduction to special machines- Stepper motors- Working principle and its types- Characteristics of stepper motors- Switched reluctance motors- construction and working of SRM- Synchronous reluctance motors- construction- working- characteristics- Permanent magnet brushless dc motors- single phase induction motors- universal motors- servomotors and its application.

Expected outcome .

- The students will get knowledge on the construction , working and characteristics of of stepper motors, synchronous motors, PMDC motors and switched reluctance motors, servo motors and single phase induction motors.

Text Book:

1. Miller T J E, Switched Reluctance Motor and Their Control, Clarendon Press, Oxford,1993.
2. Miller T J E, Brushless Permanent Magnet and Reluctance Motor Drives, Clarendon Press,Oxford,1989.
3. B K Bose, Modern Power Electronics & AC drives, Pearson, 2002.
4. Athani V.V. "stepper motors – Fundamentals, Applications &Design" New Age International

References:

1. Kenjo T, Sugawara A, Stepping Motors and Their Microprocessor Control, Clarendon Press, Oxford, 1994.
2. Kenjo T, Power Electronics for the Microprocessor Age, Oxford University Press, 1990.
3. Ali Emadi (Ed), Handbook of Automotive Power Electronics and Motor Drives, CRC Press, 2005.
4. R Krishnan, Electric Motor Drives – Modeling, Analysis and Control, PHI, 2003.
5. H A Toliyat, S Campbell, DSP Based Electro Mechanical Motion Control, CRC Press, 2004.Tamil Nadu 1999.
6. Arumugam & Premkumar, Electric Circuit Theory, Khanna Publishers. 2002

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Stepper Motors - Constructional features- principle of operation- modes of excitation- Types- single phase stepping motors- torque production in variable Reluctance (VR) stepping motor- Dynamic characteristics- Application of stepper motors in mechatronics systems	7	15%

II	Switched Reluctance Motors - Constructional features- principle of operation- Torque equation- Power controllers- Characteristics and control- Applications	7	15%
FIRST INTERNAL EXAMINATION			
III	Synchronous Reluctance Motors-Constructional features: axial and radial air gap Motors- Operating principle- reluctance torque – Phasor diagram- motor characteristics- Applications	7	15%
IV	Permanent Magnet Brushless DC Motors - Commutation in DC motors-- Difference between mechanical and electronic commutators- Hall sensors- Optical sensors- Multiphase Brushless motor- Square wave permanent magnet brushless motor drives- - Torque and emf equation- Torque speed characteristics- Controllers- Microprocessor based controller- Sensor less control	7	15%
SECOND INTERNAL EXAMINATION			
V	Permanent Magnet Synchronous Motors - Principle of operation- EMF- power input and torque expressions- Phasor diagram- Power controllers- Torque speed characteristics- Self Control- Vector control- Current control schemes- Sensor less control	7	20%
VI	**SPECIAL MACHINES / APPLICATIONS** Working principle of single phase induction motor – capacitor start & capacitor run motors – Universal motor – servomotor – Applications of Servo motors in Mechatronics.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

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8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

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5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions (3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks))

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR468	Research Methodology	3-0-0-3	2016

Prerequisite : NIL

Course Objectives

- To impart knowledge on the methodologies followed in engineering research.
- To impart knowledge on formulation of research problems and to apply the same in projects

Syllabus

Research Concepts-. Types of research- Research process- Research design- Data collection methods- Formulation of Research Task- Mathematical modelling and simulation- Report writing

Expected outcome .

- The student will acquire scientific, statistical and analytical knowledge for carrying out research work effectively.

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Text Books:

1 J.W Bames, Statistical Analysis for Engineers and Scientists, McGraw Hill, N.York
2. Schank Fr., Theories of Engineering Experiments, Tata Mc Graw Hill Publication.
3. C. R. Kothari, Research Methodology, New Age Publishers.
4. Willktnsion K. L, Bhandarkar P. L, Formulation of Hypothesis, Himalaya Publication.

References:

1. Donald R. Cooper and Ramela S. Schindler, Business Research Methods, Tata McGraw- Hill Publishing Company Limited, New Delhi, 2000
2.Uma Sekaran, Research Methods for Business, John Wiley and Sons Inc., New York, 2000.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Research Concepts – concepts – meaning – objectives – motivation- Types of research – descriptive research – conceptual research – theoretical research – applied research – experimental research	7	15%
II	Research process – Criteria for good research – Problems encountered by Indian researchers- Research design – Purpose of the study: Exploratory- Descriptive- Hypothesis Testing	7	15%
	FIRST INTERNAL EXAMINATION		
III	Data collection methods - Interviewing- Questionnaires- etc- Secondary sources of data collection- Guidelines for Questionnaire Design – Electronic Questionnaire Design and Surveys	7	15%

IV	Formulation of Research Task – Literature Review – Importance & Methods – Sources – Quantification of Cause Effect Relations- Discussions – Field Study – Critical Analysis of Generated Facts – Hypothetical proposals for future development and testing- selection of Research task	7	15%
SECOND INTERNAL EXAMINATION			
V	Mathematical modelling and simulation – Concepts of modelling – Classification of mathematical models – Modelling with – Ordinary differential equations – Difference equations – Partial differential equations – Graphs – Simulation – Process of formulation of model based on simulation.	7	20%
VI	Interpretation and report writing – Techniques of interpretation – Precautions in interpretation – Significance of report writing – Different steps in report writing – Layout of research report – Mechanics of writing research report – Layout and format – Style of writing – Typing – References – Tables – Figures – Conclusion– Appendices	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions (3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks))

Course code	Course Name	L-T-P - Credits	Year of Introduction
**341	DESIGN PROJECT	0-1-2-2	2016

Prerequisite : Nil

Course Objectives

- To understand the engineering aspects of design with reference to simple products
- To foster innovation in design of products, processes or systems
- To develop design that add value to products and solve technical problems

Course Plan

Study : Take minimum three simple products, processes or techniques in the area of specialisation, study, analyse and present them. The analysis shall be focused on functionality, strength, material, manufacture/construction, quality, reliability, aesthetics, ergonomics, safety, maintenance, handling, sustainability, cost etc. whichever are applicable. Each student in the group has to present individually; choosing different products, processes or techniques.

Design: The project team shall identify an innovative product, process or technology and proceed with detailed design. At the end, the team has to document it properly and present and defend it. The design is expected to concentrate on functionality, design for strength is not expected.

Note : The one hour/week allotted for tutorial shall be used for discussions and presentations. The project team (not exceeding four) can be students from different branches, if the design problem is multidisciplinary.

Expected outcome.

The students will be able to

i. Think innovatively on the development of components, products, processes or technologies in the engineering field
ii. Analyse the problem requirements and arrive workable design solutions

Reference:

Michael Luchs, Scott Swan, Abbie Griffin, 2015. Design Thinking. 405 pages, John Wiley & Sons, Inc

Evaluation

First evaluation (Immediately after first internal examination) 20 marks
Second evaluation (Immediately after second internal examination) 20 marks
Final evaluation (Last week of the semester) 60 marks

Note: All the three evaluations are mandatory for course completion and for awarding the final grade.

Course code	Course Name	L-T-P - Credits	Year of Introduction
**352	Comprehensive Examination	0-1-1-2	2016
Prerequisite : Nil			

Course Objectives

- To assess the comprehensive knowledge gained in basic courses relevant to the branch of study
- To comprehend the questions asked and answer them with confidence.

Assessment

Oral examination – To be conducted by the college (@ three students/hour) covering all the courses up to and including V semester– 50 marks

Written examination - To be conducted by the Dept. on the date announced by the University– common to all students of the same branch – objective type (1 hour duration)– 50 multiple choice questions (4 choices) of 1 mark each covering the six common courses of S1&S2 and six branch specific courses listed – questions are set by the University - no negative marks – 50 marks.

Note: Both oral and written examinations are mandatory. But separate minimum marks is not insisted for pass. If a students does not complete any of the two assessments, grade I shall be awarded and the final grade shall be given only after the completion of both the assessments.

The two hours allotted for the course may be used by the students for discussion, practice and for oral assessment.

Expected outcome.

- The students will be confident in discussing the fundamental aspects of any engineering problem/situation and give answers in dealing with them

Course code	Course Name	L-T-P - Credits	Year of Introduction
**451	Seminar and Project Preliminary	0-1-4-2	2016
Prerequisite : Nil			

Course Objectives

- To develop skills in doing literature survey, technical presentation and report preparation.
- To enable project identification and execution of preliminary works on final semester project

Course Plan

Seminar: Each student shall identify a topic of current relevance in his/her branch of engineering, get approval of faculty concerned, collect sufficient literature on the topic, study it thoroughly, prepare own report and present in the class.

Project preliminary:

Identify suitable project relevant to the branch of study. Form project team (not exceeding four students). The students can do the project individually also. Identify a project supervisor. Present the project proposal before the assessment board (excluding the external expert) and get it approved by the board.

The preliminary work to be completed: (1) Literature survey (2) Formulation of objectives (3) Formulation of hypothesis/design/methodology (4) Formulation of work plan (5) Seeking funds (6) Preparation of preliminary report

Note: The same project should be continued in the eighth semester by the same project team.

Expected outcome.

The students will be able to

i. Analyse a current topic of professional interest and present it before an audience
ii. Identify an engineering problem, analyse it and propose a work plan to solve it.

Evaluation

Seminar : **50 marks**

(Distribution of marks for the seminar is as follows: i. Presentation : 40% ii. Ability to answer questions : 30% & iii. Report : 30%)

Project preliminary : **50 marks**(Progress evaluation by the supervisor : 40% and progress evaluation by the assessment board excluding external expert : 60%. Two progress evaluations, mid semester and end semester, are mandatory.)

Note: All evaluations are mandatory for course completion and for awarding the final grade.

Course code	Course Name	Credits	Year of Introduction
**492	PROJECT	6	2016
Prerequisite : Nil			

Course Objectives

- To apply engineering knowledge in practical problem solving
- To foster innovation in design of products, processes or systems
- To develop creative thinking in finding viable solutions to engineering problems

Course Plan

In depth study of the topic assigned in the light of the preliminary report prepared in the seventh semester
Review and finalization of the approach to the problem relating to the assigned topic
Preparing a detailed action plan for conducting the investigation, including team work
Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed
Final development of product/process, testing, results, conclusions and future directions
Preparing a paper for Conference presentation/Publication in Journals, if possible
Preparing a report in the standard format for being evaluated by the dept. assessment board
Final project presentation and viva voce by the assessment board including external expert

Expected outcome

The students will be able to

iii. Think innovatively on the development of components, products, processes or technologies in the engineering field
iv. Apply knowledge gained in solving real life engineering problems

Evaluation

Maximum Marks : 100

(i) Two progress assessments	20% by the faculty supervisor(s)
(ii) Final project report	30% by the assessment board
(iii) Project presentation and viva voce	50% by the assessment board

Note: All the three evaluations are mandatory for course completion and for awarding the final grade.