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
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
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
**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
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