6th Semester Mechanical Engineering					
Course No.	***Course Name***	***Credits***	***L***	***T***	***P***
MEC 601	Automatic Control	4	3	1	0
MEC 602	Machine Design-II	4	3	1	0
MEC 603	Fundamentals of Tribology	4	3	1	0
MEC 604	Linear Optimization in Engineering	4	3	1	0
MEC 605	Introduction to Mechatronics	4	3	1	0
MEC 606	SEMINAR	3	0	0	6
MEC 603P	Fundamentals of Tribology Lab.	1	0	0	2
MEC 605P	Mechatronics-Lab.	1	0	0	2
	Total of Credits & LTP	**25**	**15**	**05**	**10**

Course No.: MEC 601 **AUTOM\TIC CONTROL** **C L T(4 3 1)**

COURSE OUTCOME:

1. **Develop the mathematical models of LTI dynamic systems,determine their transfer functions,describe quantitatively the transient response of LTI systems,interpret and apply block diagram representations of control systems and understand the consequences of feedback.**
2. **Use poles and zeroes of the transfer functions to determine the time response and performance characteristics and design PID controllers using empirical tuning rules.**
3. **Determine the stability of linear control systems using the Routh-Hurwitzcriterion and classify systems as asymptotically and BIBO stable or unstable.**
4. **Determine the effect of loop gain variations on the locationof closed-loop scales,sketch the root locus and use it to evaluate parameter values to meet the transient reponse specification od closed loop systems.**
5. **Define the frequency response and plot asymptotic approximations to the frequency response fumction of a system.Sketch a Nyquist diagram and use the Nyquist criterion to determine the stability of a system.**

UNIT I

Introduction: Concept of automatic control, open loop and closed loop systems, servo mechanism, block diagram, transfer function.

Representation of control components and systems: Translation and rotational mechanical components, electrical components -series and parallel combinations, comparators for rotational and linear motions, integrating devices, hydraulic servomotor temperature control systems ,speed control systems.

UNIT II

System response: First and second order systems, response to step, pulse, ramp and sinusoidal inputs, systems with distance velocity lag.

Modes of controls: Proportional control, Proportional pulse reset control, proportional pulse rate control, proportional reset rate control, two position control.

Controller Mechanism: Pneumatic, hydraulic and electric controllers, general principles and circuits for generating various control actions.

UNIT III

Control system analysis: Transient response of simple control systems, stability of control systems, Mouths criterion. Frequency response analysis, polar rectangular and logarithmic plots, experimental determination of frequency response, Bode and Inquest stability criteria, gain and phase margins. Root locus plots of simple transfer function, transient response from root locus.

Electronic Analogue computers: Elements of analogue computers, solution of simple differential equations.

Text Book:

1. Ogata,K., " Modern Control engineering", *Prentice Hall of India, 3rd edition, New Delhi, 1997.*

Reference Book:

1. Raven, F., "Automatic Control" *McGraw Hill Int., 1999.*

Course No.: MEC 602 **MACHINE DESIGN- II** **C L T(4 3 1)**

COURSE OUTCOME:

1. **Analyse the stress and strain of mechanical components.**
2. **Demonstrate knowledge of basic machine elements used in machine design.**
3. **Design machine elements to perform functions in order to obtain desired objectives under various operating conditions.**
4. **Conduct a failure analysis for the design of mechanical components to select the suitable materials and manufacturing considerations.**

UNIT I

Design of friction elements, various types of brakes, design equations for various types of brakes, design analysis of all types of brakes, e.g., band brake, long shoe brake, etc. design analysis of all types of clutches, design of couplings and keys for shafts, etc, design and analysis of flat and V-belt, equations for power, slip, etc, design of chain drive.

UNIT II

Introduction to gear design, design of spur gear, equation for σ_b and σ_c for spur gear, design analysis for bending, force analysis for Helical gear, design analysis for helical gear, design of bevel gear, determination of bearing forces, horizontal and vertical shafts, design analysis for bevel gear , design analysis for worm gear.

UNIT III

Introduction to Plain bearings, Bearing surface at Micro level, Derivation of Energy equation and PV factor , PV graph, Values of PV , Derivation of Wear coefficient equation, Step-by-step procedure for Plain bearing design, Self lubricating bearings and use of clearance for life of bearing, Design of Hydrodynamic bearings, Derivation of Reynolds equation for three dimensional case, Journal bearing geometry,Variation of viscosity with pressure and temperature, Viscosity index, Sommerfeld number, Analysis of ho, h_{min}, Q_{in}, Q_{loss}, T_{in} , T_{out}, Introduction to Rolling element bearings, Design of AFB (??) , Equations for L_{10} life, Static loading and dynamic loading ,Use of AFB catalogue, Determination of Load based on radial and thrust load for ball bearings, Derivation of Load equation for Tapered AF (??) bearings, Design analysis on the basis of loads and selection of AFB from a catalogue.

Text Books:

1. Mot, R.L., "Machine Elements in Mechanical Design", *Maxwell Macmillan Intl. edition N.York , USA, 1992.*

2. Shigley, J.E., "Machine Engineering Design*", McGraw Hill, higher education,2004.*

Reference Books:

Shigley, J.E., Mischke, C. Brown T., “Standard Hand book of Machine Design” *McGraw Hill.*

Course No.: MEC 603 **FUNDAMENTALS OF TRIBOLOGY** **CL T (4 3 1)**

COURSE OUTCOME:

1. **To introduce students the field of tribology and its historical development and understand the surface phenomena related to relative motion and the nature of friction.**
2. **Students will demonstrate the role of tribology in industry and also reveal the basic understanding of friction.**
3. **Understand the concept of friction, wear, analysis of friction & wear, techniques to control the wear and measurement technique to analyze friction and wear.**
4. **Familiar the students with the concept of lubricants, types of lubricants, compare boundary lubrication, mixed lubrication and hydrodynamic lubrication and materials for tribological applications.**

UNIT I

Introduction to tribology, tribology in Industry, energy saving through tribology engineering, Surfaces and interaction between surface, production of engineering surface, surface roughness, RMS value, average value and ten point average of surface roughness. Development of engineering surface and measurement of surface roughness, Tribology in Industry, Losses of due to friction and wear in industry, Tribo-elements and a systems concept in tribology, Introduction to friction static and dynamic friction analysis, Da Vinci concept of friction, Amonton's laws of friction, Coulomb's laws of friction, Bowden and Tabor concept of friction.

UNIT II

Wear and Types of wear, adhesive wear and its mathematical model, Two body abrasive wear, Three body abrasive wear, abrasive wear and its mathematical model, corrosive wear model, erosive wear model, cavitation wear, scuffing wear, delimination wear, pitting wear, wear coefficient and wear measurement, wear measurement through Pin- on- Disc machine, Pin-on-ring, Profilometer, wear coefficient of various materials,

UNIT III

Lubricants, types of lubricants, physical adsorption, Chemisorption, Self lubrication properties of materials, Solid lubrication, Lubrication in space, Food industry, etc, High temperature lubrication, Hydrodynamic lubrication, Various components of Reynolds equation, Sommerfeld number and its use in hydrodynamic lubrication, Materials for tribological applications.

Text Books :

1. Czichos, H., "A system approach to science and Technology of Friction, Lubrication

and Wear" Volume I, Tribology series, *Elsevier Publications, , 1978*.
2. Glaeser, J " Marerials for Tribology",Tribology series Vol. 20, *Elsevier Publications, , 1992.*

Reference Books:

1. Peterson M.B.,Winner W.O, "Wear control Handbook" *sponsored by The Research Committee on Lubrication, Publsher, , 1980.*
2. Cameron A., "The principles of Lubrication", *Longman, London, 2000*.

Course No.: MEC 604 **LINEAR OPTIMIZATION IN ENGINEERING** **C L T (4 3 1)**

COURSE OUTCOME:

1. **Develop critical thinking and objective analysis of real life decision problems which could be analysed under the ambit of operations research.**
2. **Formulate and solve linear programming problems using appropriate technique and models,interpret the results obtained and translate solutions into directives for action.**
3. **Realise the project life cycle and perform project planning activities that accurately forecast project costs and quality in order to implement processes for successful resource ,time,communication and change management.**
4. **Analyse and solve real life individual engineering problems,using mathematical tools,arising from a wide range of applications.**

UNIT I

Overview of Operations Research (OR), OR Methodology and techniques, Introduction to Linear Programming (LP), Application of LP techniques in Production management, graphical solutions, the simplex method, Duality and Sensitivity analysis, transportation model problems and their variants, assignment model problems.

UNIT II

Project planning and scheduling, CPM & PERT, Project crashing and recourse allocation problems, decision theory, steps in decision making, decision making under uncertainty and under risk, marginal analysis, decision trees.

UNIT III

Flow shop scheduling, Job shop scheduling, Queuing theory and their applications, Waiting line models and their applications, introduction and basic concepts of Simulation.

Text Book:

1. Taha, H.A., "Operation Research- an Introduction", 6th edition, Prentice Hall of India, New Delhi, 2000.

Reference Books:

1. Joseph Ecker, Michael K, "Introduction to Operations Research" *John Wiley & Son, ,1998.*
2. Hillier &Lieberman, "Introduction to Operations Research", *McGrawHill, Singapore,2001.*
3. Gupta M.P, Khanna R.B., "Quantitative Techniques for Decision Making", *Prentice Hall of India, New Delhi, 2008.*

Course No.: MEC 605 INTRODUCTION TO MECHATRONICS C L T (4 3 1)

COURSE OUTCOME:

1. **Explain the architecture of various mechatronics systems.**
2. **Identify and analyse the modern electrical and electronics components used in mechatronic systems.**
3. **Select and integrate various sensors and actuators to meet a mechatronic product requirement.**
4. **Determine and analyse the dynamic response of the zero,first and second order mechatronic systems.**
5. **Program and analyse new mechatronic products using embedded systems.**

UNIT I

Introduction to mechatronics, mechatronic design approach, system interfacing, instrumentation and control systems microprocessor-based controllers and microelectronics, mechatronics; a new directions in nano-, micro-, and mini-scale, electromechanical systems design, physical system modelling, electromechanical systems structures and materials, modelling of mechanical systems for mechatronics applications,

UNIT II

Sensors and actuators, fundamentals of time and frequency, sensor and actuator characteristics, linear and rotational sensors, acceleration sensors, force measurement, torque and power measurement, flow measurement, temperature measurements, distance measuring and proximity sensors, light detection; image, and vision systems, integrated micro-sensors, actuators; electro-mechanical actuators, electrical machines, piezoelectric actuators; hydraulic and pneumatic actuation systems.

UNIT III

Microtransducers analysis, design and fabrication, role of controls in mechatronics, role of modeling in mechatronics design, response of dynamic systems, introduction to computer and logic systems, logic concepts and design system interfaces, communication and computer networks, fault analysis in mechatronic systems, logic system design, programmable logic controllers, software and data acquisition.

Text Book:

1. Shetty D., Richard A.K., "Mechatronics system design", *Cengage learning, , 2011*.

Reference Books:

1. Dan S.N., "Mechatronics" *Prentice Hall, , 2002.*

2. “Micromechatronics - Modeling, Analysis, and Design with Matlab”, *CRC Press, London, 2004.*

MEC 603 P FUNDAMENTALS OF TRIBOLOGY LAB C P (1 2)

COURSE OUTCOME:

1. **Demonstrate the preparation of samples for friction and wear tests.**
2. **Conduct the experimentation to measure the friction analysis of various engineering materials.**
3. **Conduct the experimentation to measure the wear analysis of various engineering materials.**
4. **Perform wear and extreme pressure test and analysis of particle count and wear shape classification of different types of lubricants.**

1. Preparation of samples for friction and wear tests.
    - Polishing
    - Cleaning.
2. Microhardness Measurement; Knoop and Vicker for metals, polymers and ceramics
    - HV V/s Load plots.
    - HK V/s Load Plots.
    - Influence of indentation time.
    - HV V/s Indentation time
    - HK V/s Indentation time
3. Measurement of Friction
4. Measurement of Wear through weight loss, etc.
5. Plot of friction coefficient V/s Load , and Plot of wear volume V/s Load
6. Calculation of wear coefficient for a metallic material.
7. Calculation of Wear coefficient for ceramics.
8. Measurement of friction in presence of lubricant at room temperature.
9. Measurement of wear under lubricated conditions for metallic materials.
10. Influence of additives on friction and wear of metals.

MEC 605P **MECHATRONICS LAB.** **C P (1 2)**

COURSE OUTCOME:

1. **Identify and use basic modern tools for measurement of electrical and electronic signals.**
2. **Identify and use different types of sensors and actuators for designing a mechatronic product.**
3. **Design basic circuits utilizing modern electrical and electronic components including operational amplifiers and integrated circuits.**
4. **Write basic microcontroller programs for controlling a mechatronic product.**

1. Sensor/Actuator - Interfacing, calibration, frequency domain characterization, MATLAB serial interface, and serial LCD display
2. Design of electropneumatic circuits for L (??) and square cyles using PLC's.
3. Sorting of components on an intelligent a conveyor system.
4. Modelling of DC Motor System.
5. DC Motor position tracking.
6. DC Motor position set-point control via PID controller, using relay automatic tuning technique7.
7. Disection of an existing system.
8. Demonstration of recent projects on Mechatronics.

Mini Project on Independent modeling, analysis, and design of a mechatronic control system (Select one "mechatronic plant" from the Quanser, rotary family).