Lecture 1

1. Define Mechatronics. Draw and describe the basic elements of Mechatronics Engineering system.
2. What do you mean by microprocessor, microcontroller and embedded systems?
3. What do you mean by transient response and steady-state response? Describe with proper examples.
4. Draw and describe the components of measurement system.
5. Mention the steps how a digital thermometer works.
6. Mention the key differences between open-loop and closed-loop control system.
7. Draw and describe the basic elements of closed-loop system.

Lecture 2 and 3

1. Differentiate between sensor and transducer.
2. Differentiate between analog and digital sensor.
3. State the key features of a smart sensor.
4. Define the following terms:
   i. Span
   ii. Hysteresis error
   iii. Non-linearity Error
   iv. Repeatability/Reproducibility
   v. Stability
   vi. Dead Band/Time
   vii. Resolution
   viii. Accuracy
   ix. Precision
5. What do you mean by the following specifications?
   i. A temperature sensor might have a range of -10°C to 100°C
   ii. A thermometer reads 25°C when the actual temperature is 24°C
   iii. A temperature-measuring instrument is specified as having an accuracy of ±2°C
   iv. A strain gauge having a sensitivity of 2 mV/V
6. Consider the significance of the terms in the following specification of a strain gauge pressure transducer:
   Ranges: 70 to 1000 kPa, 2000 to 70 000 kPa
   Supply voltage: 10 V d.c. or a.c. r.m.s.
   Full range output: 40 mV
   Non-linearity and hysteresis: ±0.5% of full range output
   Temperature range: -54°C to +120°C when operating
   Thermal zero shift: 0.030% of full range output/°C
   Interpret the following specifications.
7. List and define the static characteristics of a sensor.
8. List and define the dynamic characteristics of a sensor.

Lecture 4 and 5

1. Write the differences between the followings

i. Si vs Ge
ii. Metal, Semiconductor, Insulator
iii. Intrinsic and extrinsic semiconductor
iv. P-type and N-type semiconductor
v. Diffusion and drift current
vi. Inductor and Capacitor
vii. Analog and Digital electronic circuit
viii. Short circuit and Open circuit
ix. KVL and KCL
x. Current divider rule and voltage divider rule

2. Define the following terms:
   i. Doping
   ii. Charge
   iii. Resistance
   iv. Potential Different
   v. EMF
   vi. Voltage
   vii. Current

Lecture 6

1. Define the following terms: Force, Moment, Torque, Tensile force, compressive force, shear force, torsional moment, bending moment, gravity force, aerodynamic force, frictional force, free body diagram, displacement, velocity, acceleration, work, energy, power, stress, strain.
2. State the equilibrium conditions for a body.
3. State and explain the properties of materials.
4. Write the key function of the following mechanical components: Gear and gear trains, Linkage and cams, bearing and couplings.

Lecture 7

1. Draw and explain the working principle of the following sensors: Displacement sensor, Linear variable differential transformer

Lecture 8

1. Define proximity sensor. Write down the types of proximity sensors.
2. List the features of proximity sensors
3. Define the following terms of proximity sensors: Standard Sensing Object, Sensing Distance, Set Distance, Hysteresis (Differential Travel), Response Time, Response Frequency, Shielded vs. Unshielded Sensors,
4. Draw and explain the working principle of the following proximity sensors: Inductive proximity sensor, capacitive proximity sensor, Magnetic proximity sensor

Lecture 9

1. Draw and explain the following sensors: passive IR sensor, ultrasonic sensor, microwave sensor, condenser microphone, dynamic microphone, piezoelectric sound sensor.

Lecture 10

1. Define photodiode. Describe the types of photodiodes.
2. List the performance parameter of photodiode.
3. Describe the construction and working principle of the following sensors: Phototransistor, Photovoltaic cell, Light dependent resistor

Lecture 11

1. Define the following thermoelectric effects: Seeback effect, peltier effect, Thomson effect.
2. Describe the working principle of the following temperature sensors: Thermocouple, Thermopile, Thermoelectric generator, thermistor, resistant temperature detector.
3. State and define the types of thermistor.
4. Draw and briefly explain the two, three and four wires resistant temperature detector.

Lecture 12

1. Draw and explain the following level measurement sensors: Float level gauge, displacement level transmitter, servo level transmitter, weight and cable level transmitter, magnetic level gauge, resistive chain, hydrostatic level, capacitive level sensor.
2. Describe the working principles of the following flow meters: Venturimeter, Pitot tubes

Lecture 13

1. Draw the block diagram of hydraulic and pneumatic system.
2. Draw the gear pump, vane pump, radial piston pump, axial piston pump, reciprocating compressor, rotary vane compressor, rotary screw compressor, spool valve, poppet valve

Lecture 14

1. Define and explain freedom and constraints
2. Explain the links and joints of mechanical system
3. Define Grashof condition. Illustrates different forms of the four-bar chain by altering the relative lengths of the links.
4. Draw the position sequence for the links in a slider– crank mechanism
5. Describe the cam mechanism.

Lecture 15

1. Draw the following gears: Gear train, worm gear, spur gear, helical gear, rack and pinion gear, ratchets and pawls
2. Draw and explain the belt and chain drives.

Lecture 16 and 17

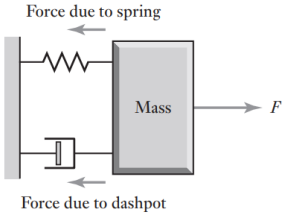
1. Draw and explain the working principle of the following electrical actuation systems: Thyristor, TRIAC, DIAC, UJT

Lecture 18

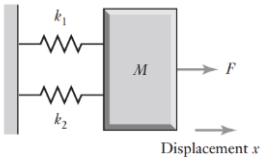
1. Describe the stepper motor driving techniques.
2. Write down the full step mode working sequence for stepper motor.

Lecture 19

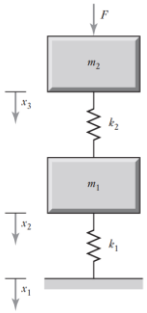
1. Develop the differential equation, describes the relationship between the input of force F to the system and the output of displacement x.



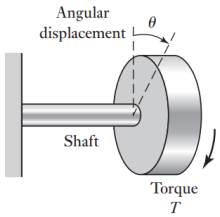
2. Develop the differential equation relating the inputs and outputs for a mechanical system



3. Derive the second-order differential equations to describe the behaviours of the system.

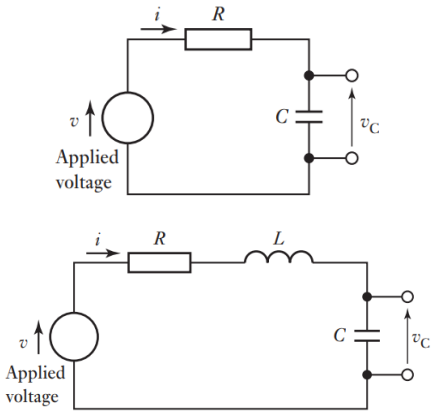


4. Evaluate the relationship between the torque and angular displacement for the system

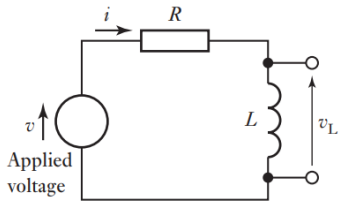


Lecture 20

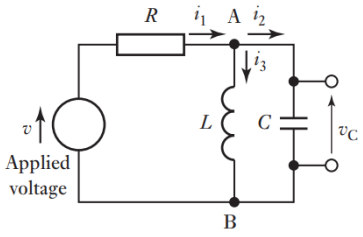
1. Derive the differential equation which gives the relationship between the output v_C and the input v.



2. Develop the relationship between the output, the potential difference across the inductor of v_L, and the input v for the circuit shown in Figure.

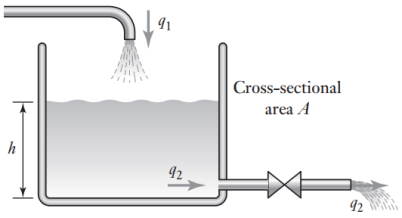


3. Develop the relationship between the output, the potential difference v_C across the capacitor, and the input v for the circuit shown in Figure.

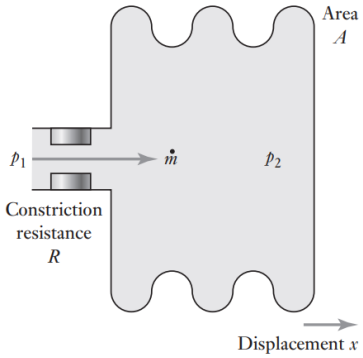


Lecture 21

1. Figure shows a simple hydraulic system, a liquid entering and leaving a container. Develop an equation describing how the height of liquid in the container depends on the rate of input of liquid into the container.

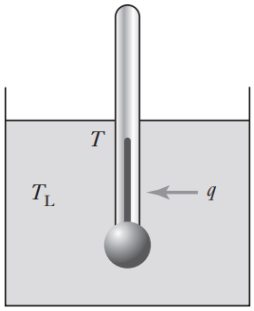


2. A bellows is an example of a simple pneumatic system. Resistance is provided by a constriction which restricts the rate of flow of gas into the bellows and capacitance is provided by the bellows itself. Inertance can be neglected since the flow rate changes only slowly. Develop an equation describing how the pressure in the bellows p_2 varies with time when there is an input of a pressure p_1.

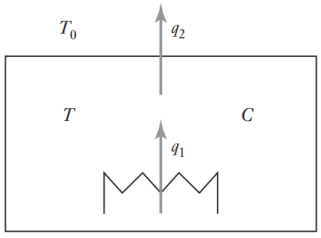


Lecture 22

1. Consider a thermometer at temperature T which has just been inserted into a liquid at temperature T_L. Develop a first-order differential equation, describing how the temperature indicated by the thermometer T will vary with time when the thermometer is inserted into a hot liquid.



2. Figure shows a thermal system consisting of an electric fire in a room. The fire emits heat at the rate q_1 and the room loses heat at the rate q_2. Assuming that the air in the room is at a uniform temperature T and that there is no heat storage in the walls of the room, derive an equation describing how the room temperature will change with time.

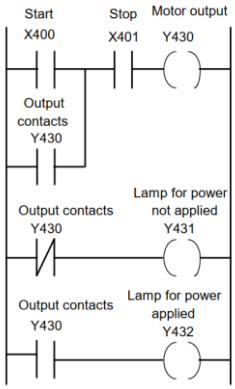


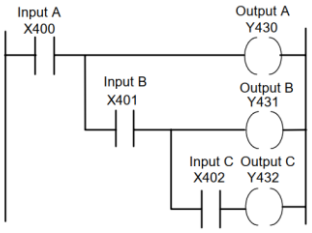
Lecture 23

1. Draw and describe the basic components of PLC system
2. Draw the internal architecture of PLC system

Lecture 24

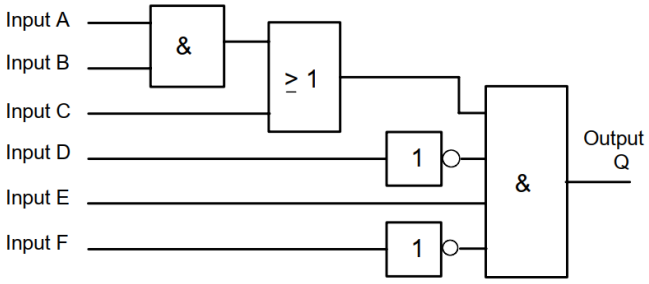
1. Draw the ladder diagram for the following logic gates: AND, OR, NOT, NAND, NOR, EX-OR
2. Consider a motor controlled by stop and start push button switches and for which one signal light must be illuminated when the power is applied to the motor and another when it is not applied. Draw the ladder diagram for this case.
3. Describe the operation of the following ladder diagrams:





Lecture 25

1. Draw the functional block diagram for the following logic gates: AND, OR, NOT, NAND, NOR, EX-OR
2. Draw the ladder diagram for the following functional block diagram.



3. A signal lamp is required to be switched on if a pump is running and the pressure is satisfactory, or if the lamp test switch is closed. Draw the ladder diagram and functional block diagram.

4. Consider a valve which is to be operated to lift a load when a pump is running and either the lift switch is operated or a switch operated indicating that the load has not already been lifted and is at the bottom of its lift channel. Draw the ladder diagram and functional block diagram.
5. Consider a system where there has to be no output when any one of four sensors gives an output, otherwise there is to be an output. Draw the ladder diagram and functional block diagram.
6. A system is to be activated when two different sets of input conditions are realised. You might just program this as an AND logic gate system; however, if a number of inputs have to be checked in order that each of the input conditions can be realised, it may be simpler to use an internal relay. The first input conditions then are used to give an output to an internal relay. This has associated contacts which then become part of the input conditions with the second input. Draw a ladder program for such a task.
7. Draw a ladder program of internal relays used for resetting a latch circuit.
8. Draw a ladder program of Battery-backed relay program.
9. Consider a fire alarm system, where fire sensors provide inputs to a SET-RESET function block so that if one of the sensors is activated the alarm is set and remains set until it is cleared by being reset. When set it sets of the alarm. Draw the ladder program for this task.