Chapter (3): Dynamic Response of Systems

Ex. Sketch and explain the response of a first-order system when subjected to step input signal. A thermometer is suddenly subjected to a step input of 200°C from 0°C. Calculate the temperature indicated by the thermometer after a time of 1.5 seconds. The thermometer may be idealized as a first order system with a time constant of 2.5 seconds. Would there be any change in the indicated temperature if the thermometer was initially
Held at 25°C?

Ex. A balloon, carrying a first order thermometer with a 15 second time constant, rises through atmosphere at a speed of 6 m/s. Assume temperature varies with altitude at a rate of 0.005°C/m. The balloon gives information about temperature and altitude through radio signals. At an altitude of 300 m, the balloon radios a temperature 15°C. What is the true altitude at which 15°C occurs?

Ex. A thermometer has a time constant of 3.5s. It is quickly taken from a temperature 0°C to water bath at 100°C. What temperature will be indicated after 1.5s?

Ex. A temperature-sensitive transducer is subjected to a sudden temperature change. It takes 10s for the transducer to reach equilibrium condition (five time constants). How long will it take for the transducer to read half of the temperature input?

Ex. A temperature sensing device can be modeled as a first order system with a time constant of 6s. It is suddenly subjected to a step input of 25°C to 150°C. What temperature will be indicated in 10s after the process has started?

Ex. The temperature of a furnace is increasing at a rate 0.1°C/s. What is the maximum permissible time constant of a first order instrument that can be used, so the temperature is read with a maximum error of 5^{o}C.

Ex. Specify the time domain parameters for the response of second order system when subjected to step input. Also, define the performance response parameters.

A second order control system was subjected to step input and the measurements indicated that the system had an overshoot of 10% in a rise time of 0.2 seconds. Make calculations for the effective damping ratio and the undamped natural frequency of the system.