FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF COMPUTER ENGINEERING, LEVEL 200

SYSTEMS ENGINEERING

CONTINUOUS ASSESSMENT

Time: 2 Hours

Answer all Questions

Question 1

Consider the unity-feedback system in fig. 1.

a) For $G(s) = \frac{K}{s(s+1)(s+2)}$, calculate the maximum value of K for stability.

b) If $G(s) = \frac{4}{s^3 + 5s + 6}$, analyze the stability of the system.

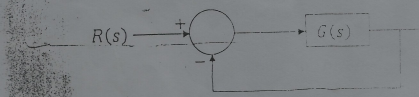

Fig. 1: Feedback configuration for question 1.

Question 2

Consider the speed control system in fig. 2. The Amplifier produces a torque which drives the motor. The Gain of the Amplifier, K=10. The motor and load have a combined moment of inertia J= 100 $100 Nm^2$ and a frictional coefficient of 10 N per rad/s.

a) Calculate the unit step response

b) Calculate the steady-state error to a unit step input

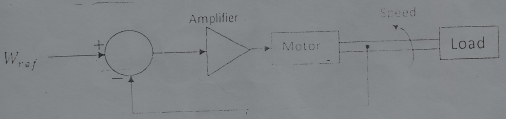

Fig. 2: A Speed Control System

Question 3

Consider rhe RL circuit in fig. 3.

a) Calculate the Transfer Function

b) Calculate the unit step response

c) If the inductor and resistor are permuted, calculate:

i) The Transfer Function

ii) The Unit Step Response

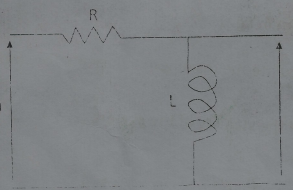

Fig. 3: An RL Circuit

Question 4

Turbine Flowmeters are the most widely used sensors for measuring Flow Rate.

a) By using an illustrative diagram briefly explain how a Turbine Flowmeter functions

b) Draw a two-subsystem model of a turbine flowmeter

c) Briefly explain the induction mechanism of a turbine flowmeter

d) A turbine flowmeter contains 120 Electromagnets imprinted at regular intervals around the circumference of the turbine wheel. The flowmeter is designed to provide a turbine speed of $\frac{\pi}{4}$ radians/s per unit volumetric flow rate ($1m^3/s$).

Calculate the number of pulses generated by the pick up coil in 1 second, when the flow rate is $10m^3/s$.

e) A sensor for measuring linear displacement uses potentiometric transduction. Draw a two-subsystem model of the sensor

f) Design the potentiometric transduction sub-system to output 0.1 Volt per cm and to measure a maximum displacement of two meters.