

GUJARAT TECHNOLOGICAL UNIVERSITY**B. E. - SEMESTER – VII • EXAMINATION – WINTER 2012****Subject code: 170302****Date: 31/12/2012****Subject Name: Physiological system modeling****Time: 10.30 am - 01.00 pm****Total Marks: 70****Instructions:**

1. Attempt any five questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1 (a)** Assume that the block diagram of a temperature-regulating space-suit to be worn by an astronaut for a mission to Mars is as shown in Figure 1. The variable "X" represents the external temperature while "Y" represents the temperature inside the space-suit. "Gc" is the steady state gain of the heating/cooling device (controller) built into the space-suit, while "Gp" represents the steady state gain associated with the thermal characteristics of the astronaut. "H" is the gain with which the internal temperature is fed back to the controller. The operating internal temperature (Y) is allowed to range from 60oF to 100oF. Assume that $G_c = 2$, $G_p = 1$, and $H = 7$. **07**
- (a) What range of external temperatures can this space-suit be used for, if it is deployed in open-loop mode?
- (b) What is the permissible range of external temperatures when the space-suit is deployed in closed-loop mode?
- (c) Based on the results obtained in (a) and (b), what can you conclude about the effect of negative feedback in this device.
- (b)** Figure 2 displays the Simulink implementation of a simplified version of the Hodgkin-Huxley model of a nerve cell. How many feedback loops are there in this model? Deduce from this diagram the transfer function relating the membrane voltage V_m (as "output") to the depolarizing stimulus X (as "input"). **07**
- Q.2 (a)** Find the transfer function and impulse response for the linear system that is characterized by the following differential equation (assuming $x(t)$ to be the input, and $y(t)$ to be the output): **07**
- $$d^2y/dt^2 + 4 dy/dt + 3 y/dt = x(t)$$
- (b)** What is linear model of respiratory system? Explain linear model of respiratory mechanics **07**
- OR**
- (b)** Explain how Robinson experiment helps to show eye muscle tension. **07**
- Q.3 (a)** Explain parametric and nonparametric system identification method. Explain anyone in detail **07**
- (b)** Explain simulink model of cardiovascular mechanism. **07**
- OR**
- Q.3 (a)** Explain oculomotor muscle model in detail **07**
- (b)** Discuss artificial brain perfusion with its schematic diagram. **07**
- Q.4 (a)** Explain adaptive characteristic of muscle stretch reflex action with figure. **07**
- (b)** Discuss Starling heart lung preparation method. **07**
- OR**
- Q.4 (a)** Find out steady state operating point of muscle stretch reflex and give its analysis using simulink block diagram. **07**
- (b)** Explain static model of respiratory control. **07**
- Q.5 (a)** Explain frequency response of Glucose Insulin regulation. **07**

- (b) Using the root-locus method, determine whether the closed-loop system shown in Figure 3 will be stable or unstable over all possible values (including negative values) of K. 07

OR

- Q.5 (a) Explain model of cheyne-stoke's breathing. 07
(b) Explain Routh Hurwitz stability criteria. 07

Figure1

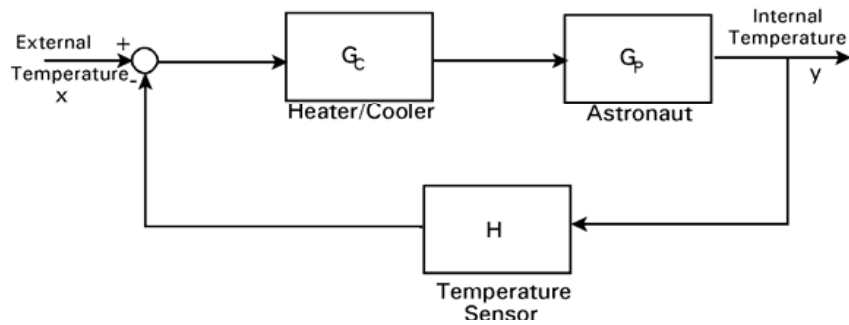
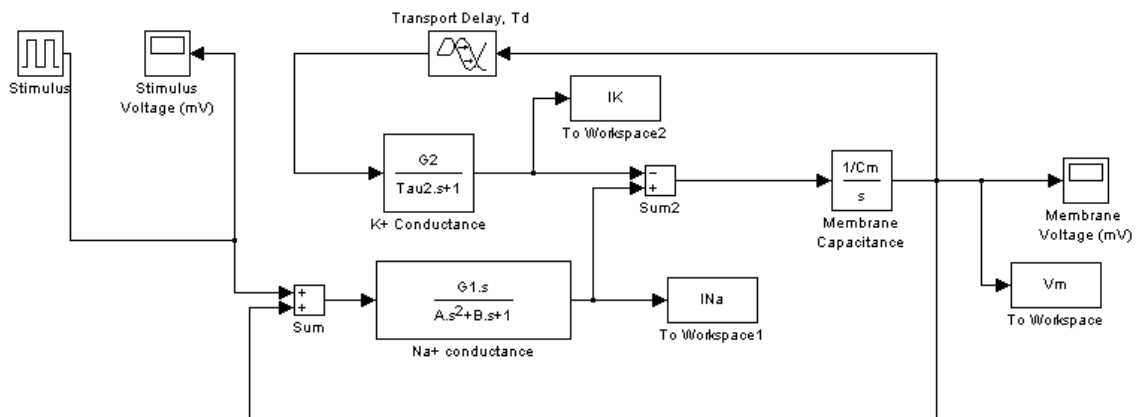


Figure 2



Note: I_{Na} = sodium current, I_K = potassium current

Transport delay, T_d : input to the block = $u(t)$, output = $u(t - T_d)$, "s" = Laplace variable

Figure 3

