

GUJARAT TECHNOLOGICAL UNIVERSITY
M. E. - SEMESTER – III • EXAMINATION – WINTER • 2014

Subject code: 734701

Date: 25-11-2014

Subject Name: Simulation and Modelling

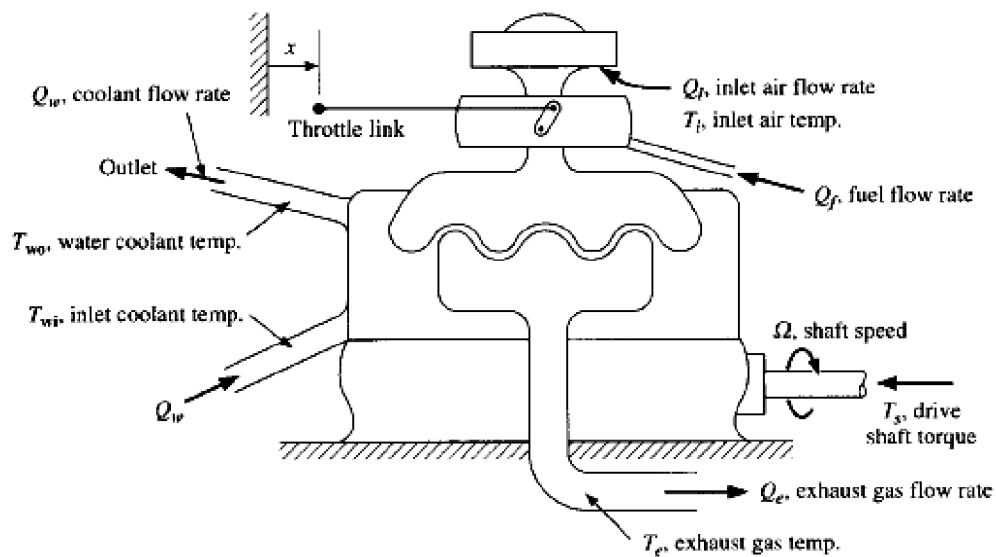
Time: 02:30 pm - 05:00 pm

Total Marks: 70

Instructions:

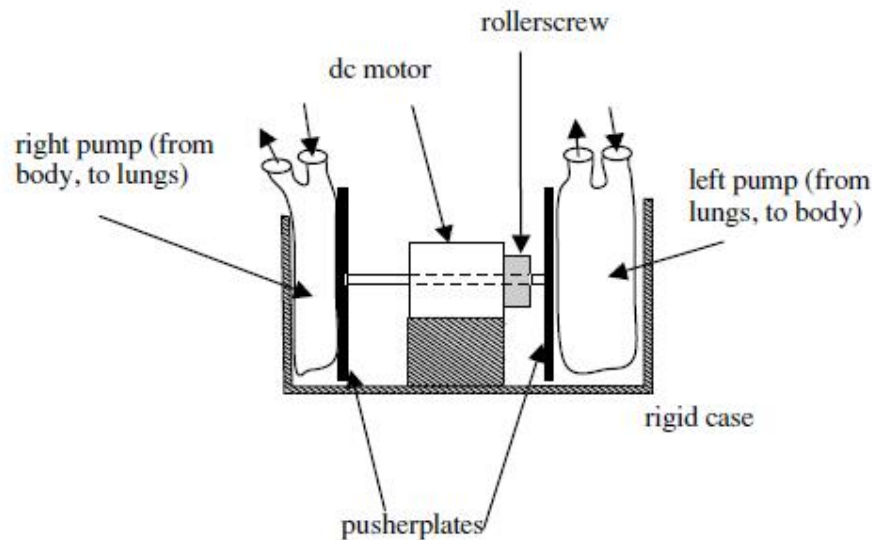
1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1** (a) Explain the significance of Modeling and Simulation as tools for solving Engineering problems 07
- (b) Explain the type of analogy using different types of variables and elements used in different systems with proper nomenclature. 07
- Q.2** (a) Give a brief classification of different types of system models based on classification criterion and types of model equations. 07
- (b) Using an input/output block diagram, such as that shown in Fig. show what you consider to be the input variables and the output variables for an automobile engine, shown schematically in Fig 07

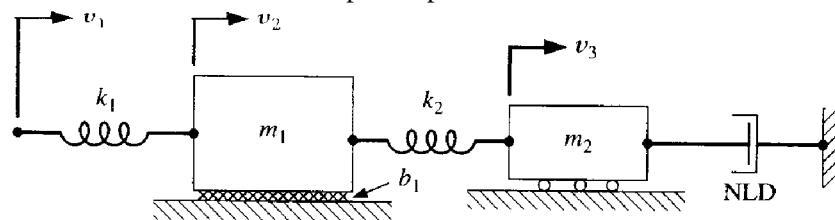


OR

- (b) A schematic representation of an artificial human heart is shown in Fig. The heart consists of two flexible chambers (blood sacs) enclosed in a rigid case. The chambers are alternately squeezed by flat plates that are, in turn, moved back and forth by a dc motor and rollerscrew arrangement. Two one-way valves (prosthetic heart valves) are used in each blood sac to ensure directional flow. The motor is powered by a battery pack through a controller circuit. The blood sac shown on the left-hand side in the figure (the right heart) takes blood returning from the body (through the vena cavae) and pumps it to the lungs (through the pulmonary artery). Oxygenated blood returns from the lungs (via the pulmonary veins) to the left heart where it is then pumped to the body through the aorta. Identify the energy-storing elements of the system. If the intent of the model is to design a control system, what would be appropriate inputs and outputs of this system?



- Q.3 (a) Differentiate between an input output model and a state model. Also explain in brief (i) State variable (ii) state vector. Develop a mathematical model for the below figure capable of relating the motions x_2 and x_3 to the input displacement x_1 .. 07

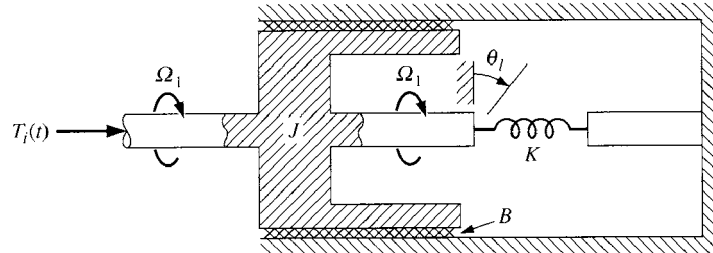


- (b) Prove that the free response of a first order system is given by 07

$$y(t) = y_0 e^{-(a_0/a_1)t}$$

OR

- Q.3 (a)** Derive a complete set of state-model equations for the mechanical rotational system shown in Fig. Select the following state variables: **07**
- (a) T-type and A-type variables,
 (b) One variable and its derivative.
- Use torque $T_i(t)$ as the input variable and angular displacement $d_i(t)$ as the input variable in each model.



- (b) It is very difficult to physically generate an ideal unit impulse function. Justify. **07**
- Q.4 (a)** Use Euler's method to obtain a numerical solution of the differential equation $4(dx/dt) + x = 4$ over a period of time from 0 to 12 s. The initial condition is $x(0) = 10$, and the system time constant is 4s. Take a time step of 0.5s. **07**
- (b) Solve **07**

$$y'' + 4y = 4t^2, y(0) = \frac{3}{2}, y'(0) = 2 \text{ by Laplace transform}$$

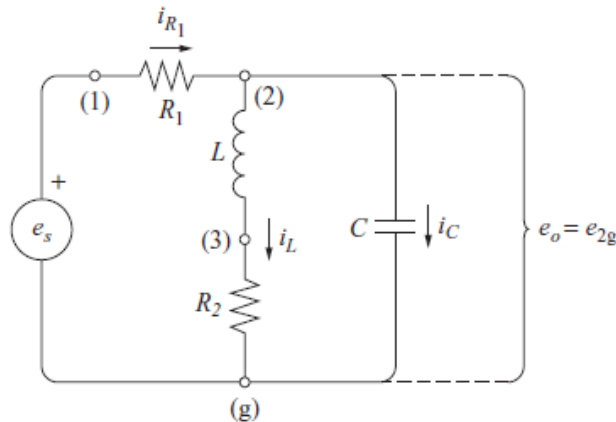
OR

- Q.4 (a)** Solve the problem mentioned in Q.4(a) above using Runge Kutta method. **07**
- (b) Solve **07**

$$\frac{d^3x}{dt^3} + 4\frac{d^2x}{dt^2} + 5\frac{dx}{dt} + 2x = 2$$

$$x(0) = \frac{dx(0)}{dt} = \frac{d^2x(0)}{dt^2} = 0$$

- Q.5 (a)** What type of models can be considered for simulation? What are the components of simulation? **07**
- (b) Find the input-output differential equation relating e_o to e_s for the simple RLC circuit shown below. **07**



OR

- Q.5 (a)** What are the factors affecting the runtime control of a dynamic system? **07**

- (b) Write the state variable equations based on the energy storage elements L and C for the circuit shown in the Figure. 07

