UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2018

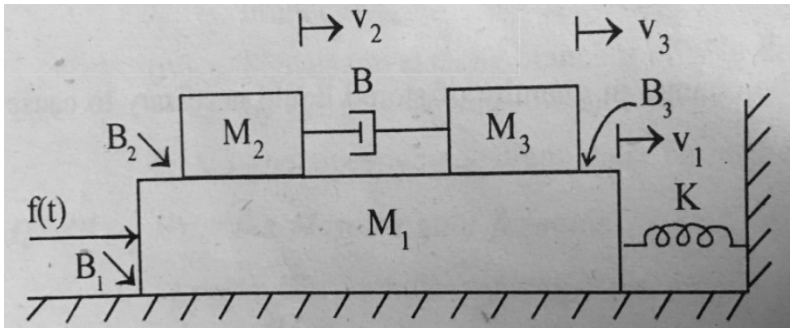
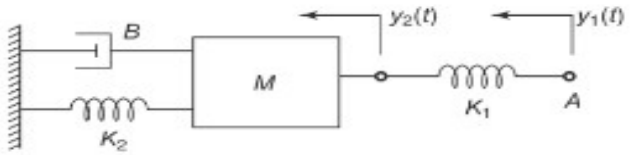
Course: Mathematical Modeling & Simulation **Semester: III**
Program: M.Tech/ASE+UAV
Time: 03 hrs. **Max. Marks: 100**
Course Code: MAEG 741

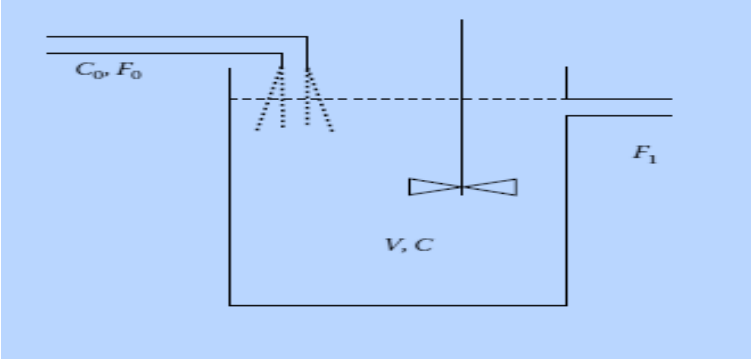
Instructions: Make use of *sketches/plots* to elaborate your answer. Brief and to the point answers are expected.
The Question paper has three sections: Section A, B and C, Section B and C have internal choices.

SECTION A

S. No.		Marks	CO
Q 1	Explain Dependent and Independent systems	**04**	**CO 1**
Q 2	List down all six DOFs for the aircraft and mention the equations as well.	**04**	**CO 2**
Q 3	Define perturbation theory concept for the aircraft under high maneuverability.	**04**	**CO 3**
Q 4	Discuss and classify the Dynamics, Kinematics and Static properties of the free body system.	**04**	**CO 3**
Q 5	List down the various differences in solving Ordinary differential equation and Partial Differential Equations for the aircraft dynamic system equation.	**04**	**CO 4**

SECTION B

Q 6	Derive the mathematical model for the system as shown in Figure 1. Determine the mathematical model to develop the relation between input and output variables.  ***Figure 1***	**10**	**CO 1**
Q 7	The input to the mechanical system, shown in Figure 2 is $y_1(t)$ at node-A. Write down the dynamic system equation and estimate the transfer function model.  ***Figure 2***	**10**	**CO 2**
Q 8	Aircraft sensor systems are equipped with three accelerometers. If the accelerometers are	**10**	**CO 3**

	located in GG, write down the acceleration values about CG in all the three direction of freedom		
Q 9	Deduce the rotation matrices for wind and stability axes. Describe in detail. ***OR*** Describe in detail the phenomenon of decoupling in longitudinal and lateral motion for the aircraft	**10**	**CO 4**
	SECTION-C		
Q 10	Consider a tank of volume V which is full of a solution of a material A at concentration C. A solution of the same material at concentration C_0 is flowing into the tank at flow rate F_0 and a solution is flowing out the top of the tank at flow rate F_1 as shown in Figure 3 . Determine the dynamic response to a step change in the inlet concentration C_0  ***Figure 3***	**20**	**CO 1**
Q 11	The flight of a model rocket can be developed as follows. During the first 0.15 s the rocket is propelled up by the rocket engine with a force of 16 N. The rocket then flies up while slowing down under the force of gravity. After it reaches its peak, the rocket starts to fall back. When its down velocity reaches 20 m /s a parachute, opens (assumed to open instantly) and the rocket continues to move down at a constant speed of 20 m/s until it hits the ground. Write a program that calculates and plots the speed and altitude of the rocket as a function of time during the flight. ***OR*** Figure 4 shows a room heated with an electric heater. The inside of the room is at temperature Tr and the walls are assumed to be at temperature Tw. If the outside temperature is To, develop a model of the system to show the relationship between the supplied heat q and the room temperature Tr. Write the program to show the thermal variation wrt time.	**20**	**CO 3**