UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination – April, 2017

Program/course: B.Tech/ASE+AVE | **Semester – VIII**
Subject: Mathematical Modeling & Simulation of A.E. | **Max. Marks : 100**
Code : AVEG 452 | **Duration : 3 Hrs**
No. of page/s: 02

INSTRUCTIONS:

1. No students will be allowed to leave the examination hall before 1hr.
2. Assume any missing data with suitable explanation.
3. All questions are compulsory for all the sections

SECTION-A

1. Explain longitudinal and lateral aircraft equation of motions **04**
2. Define various aerodynamic forces which impinges upon the aircraft surfaces 04
3. Explain Rate, pitch and yaw gyros for controlling the DoFs. **04**
4. Write the body fixed velocity vector for an aircraft. **04**
5. Write down the linear state space model for an aircraft under linear perturbation along longitudinal and lateral directions. **04**

SECTION-B

6. Derive the equation for decoupling of an aircraft in longitudinal direction. **10**

7. Write the MATLAB code for the system having the ordinary differential equation for the mass, spring and damping factor values for the time span of i) 0-25s, ii) 0-50s and iii) 0-100s.Compare the result over on the pictorial analysis. **10**
8. An airplane uses a brake parachute and other means of braking as it slows down on the runway after landing as shown in Figure 1. Its acceleration is given by $a = -0.0045\, v^2 - 3$ m/s^2. Consider an airplane with a velocity of 300 km/h that opens its parachute and starts deceleration at $t = 0$ s. Determine: **10**
(a) Velocity as function of time from $t = 0$ until airplane stops.
(b) Distance that airplane travels as a function of time.

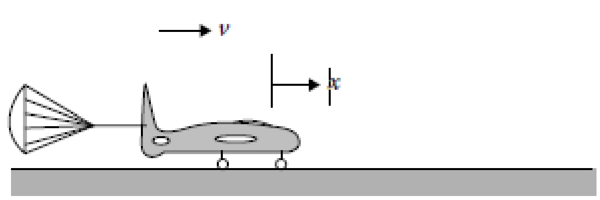

Figure 1

9. Discuss the block diagram as shown in Figure 2. **10**

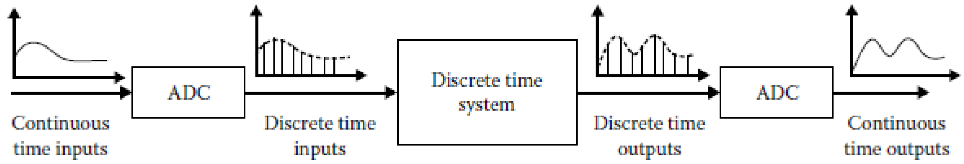

Figure 2

SECTION-C

10. Figure 3 shows a dc motor circuit with a load connected to the motor shaft. Assume that the shaft is rigid, has negligible mass, and has no torsional spring effect or rotational damping associated with it. Derive an expression for the mathematical model for the system. **20**

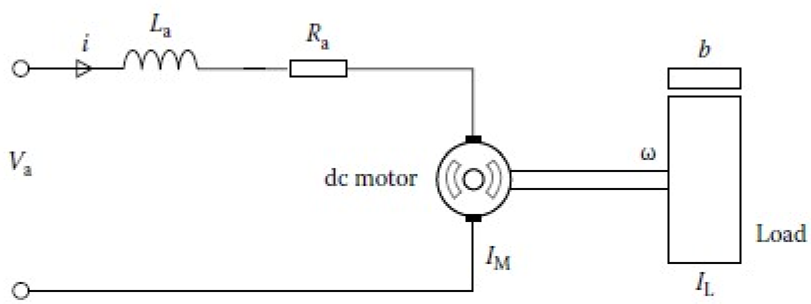

Figure 3

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. **20**

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SECTION-A

1. Differentiate between kinetics and kinematics for the system body **04**
2. Write down the aircraft model in matriculation format **04**
3. Explain Rate, pitch and yaw gyros for controlling the DoFs. **04**
4. Write the body fixed velocity vector for an aircraft. **04**
5. Write down the linear state space model for an aircraft under linear perturbation along longitudinal and lateral directions. **04**

SECTION-B

6. An airplane uses a brake parachute and other means of braking as it slows down on the runway after landing as shown in Figure 1. Its acceleration is given by $a = -0.0045\, v^2 - 3$ m/s^2. Consider an airplane with a velocity of 300 km/h that opens its parachute and starts deceleration at $t = 0$ s. Determine: **10**
   (a) Velocity as function of time from $t = 0$ until airplane stops.
   (b) Distance that airplane travels as a function of time.

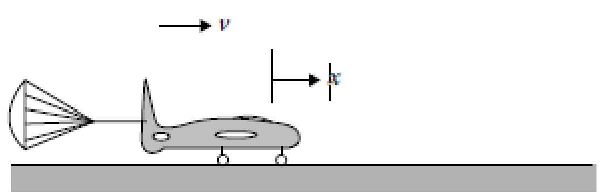

Figure 1

7. Derive the equation for decoupling of an aircraft in lateral direction. **10**

8. If the A/c accelerometers are located in GG, write down the acceleration values about CG in all the three direction of freedom **10**

9. Define the term ‘perturbation’. How would you classify the nominal and perturbation values? Write the equation for same. Using this theory, linearize the rigid body kinetics under equilibrium condition. Also, provide the equation of surge using the linearized perturbation theory. **10**

SECTION-C

10. Figure 3 shows a dc motor circuit with a load connected to the motor shaft. Assume that the shaft is rigid, has negligible mass, and has no torsional spring effect or rotational damping associated with it. Derive an expression for the mathematical model for the system. **20**

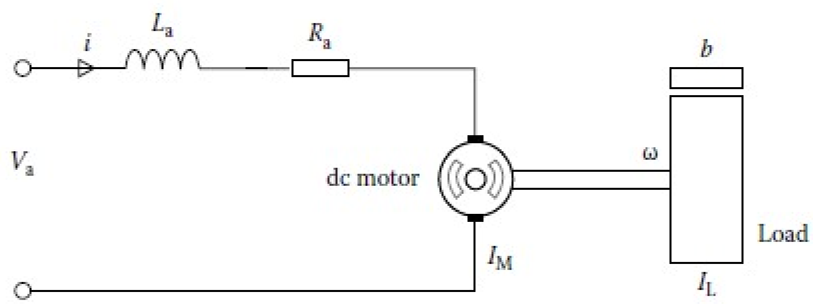

Figure 3

11. Consider a mechanical coupler normally used for coupling of two railway coaches as shown in Figure 4. The equivalent system of railway coupling is shown in Figure 2.25, which consists of two masses, a spring, a dashpot, and forces applied to each mass. Derive an expression for the mathematical model of the system. **20**

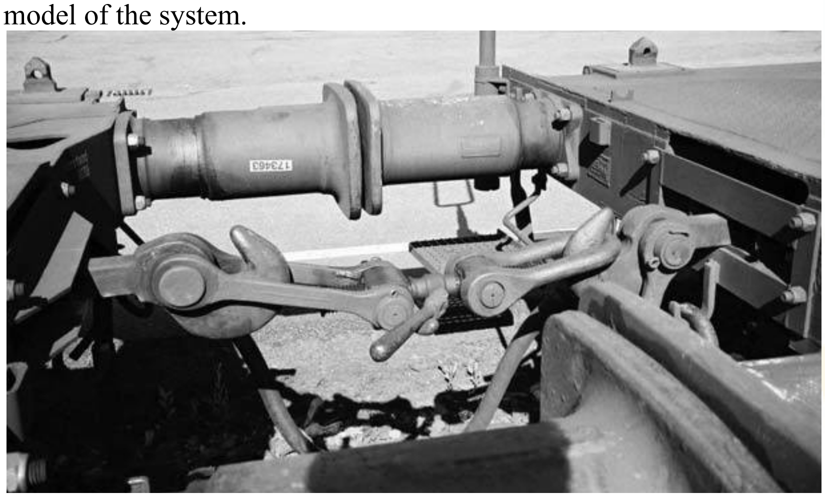

Figure 4