

Date: \_\_\_ September 2010 AN/FN

Time: 2 Hrs

Full Marks: 30

No. of Students: 110

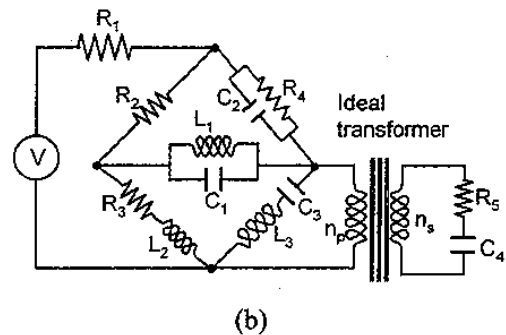
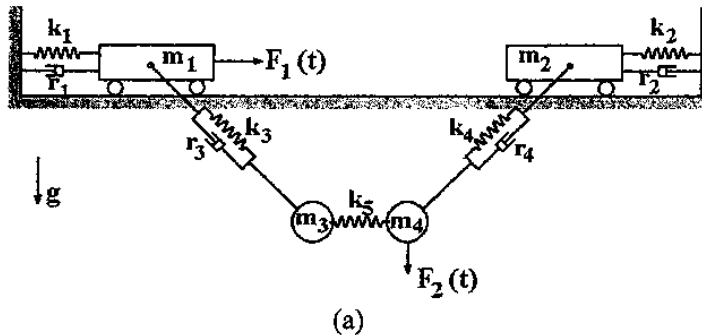
Semester: Autumn

Department: Mechanical Engineering

Sub. Name: Systems and Control

Instructions: Answer all questions. Neglect gravity unless stated.

1. Draw augmented (power directed and causalled) bond graph models of the following systems. Gravity should be considered in mechanical system model. (6x2=12 marks)

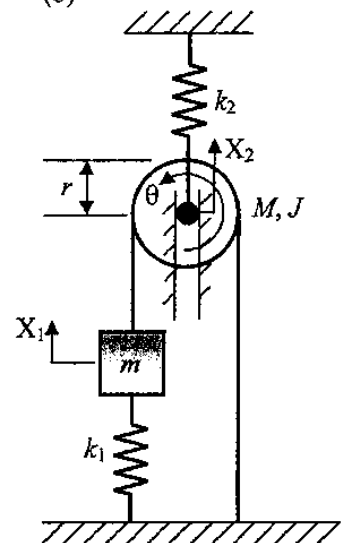


2. In the single-degree-of-freedom system shown in figure, the center of the pulley can move along a vertical slot. There is no resistance to pulley's translational and rotational motions. The mass, rotary inertia and radius of the pulley are  $M$ ,  $J$  and  $r$ , respectively. There is no slip between the pulley and the rope.

Draw an augmented (power directed and causalled) bond graph model of the system. Use transformer equivalence to reduce the model to that of a single oscillator (one spring - one mass system) with  $\dot{X}_1$  as the reference velocity.

Find the natural frequency of vibration of the system in terms of the variables mentioned in the Figure.

(8 marks)



3. Draw an augmented bond graph model of the system shown in the figure and derive the equations of state in state-space matrix form. Rolling resistance is to be neglected during modeling.

(10 marks)

