جامعة بيرزيت
BIRZEIT UNIVERSITY

Faculty of Engineering and Technology
Department of Mechanical and Mechatronics Engineering
First Examination – Fall 2016

ENME 438: Control Theory	Student ID: _____
Date of Examination: 30/10/2016	Time duration: 90 minutes
Instructor: Eng. Sima Rishmawi	Total Marks: 100

This exam contains 2 pages (including this cover page) and 4 problems. Check to see if any pages are missing. Enter your Student ID number on the top of this page, and on the Answer Booklet.

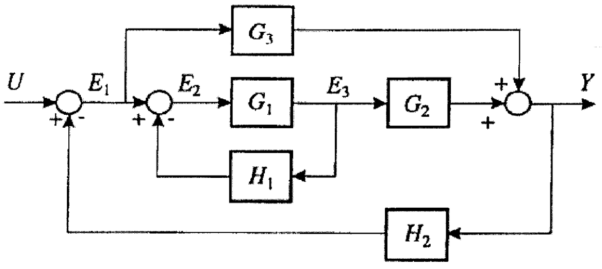
You may *not* use your books, notes, or any other reference on this exam, except for a one-sided A4 cheat sheet (to be handed in with your exam). You can use your own calculator only. Borrowing calculators is not allowed.

You are required to hand in the exam paper with your answer booklet. Failure to do so, will cause you to fail the exam.

You are required to show your work on each problem on this exam. The following rules apply:

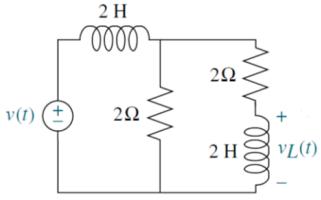
- **If you use a "certain principle" you must indicate this** and explain why the principle may be applied.
- **Organize your work**, in a reasonably neat and coherent way. Work scattered all over the page without a clear ordering will receive very little credit.
- **Mysterious or unsupported answers will not receive full credit**. A correct answer, unsupported by calculations, explanation, or algebraic work will receive no credit; an incorrect answer supported by substantially correct calculations and explanations might still receive partial credit.

1) Using block diagram algebra, reduce the block diagram show in the figure below to find the transfer function $T(s) = \frac{Y(s)}{U(s)}$. Show all the steps in detail.



20 marks

2) For the network shown in the figure, derive the transfer function $G(s) = \frac{V_L(s)}{V(s)}$.



20 marks

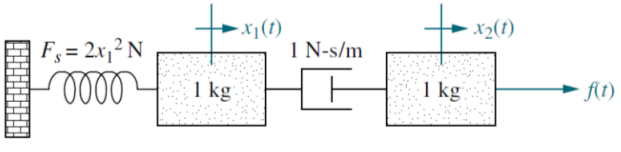
3) If a system has an open loop transfer function described by the expression below:

$$G(s) = \frac{6}{s^3 + 8s^2 + 19s + 6} \tag{1}$$

1. Find the unity feed back closed loop transfer function $T(s)$. Draw a block diagram to clarify your answer.
2. If a step input $r(t) = 2u(t)$ is applied to the closed loop system $T(s)$, find an expression for the system response $y(t)$.
3. What is the final value of $y(t)$.

30 marks

4) Consider the mechanical system in the figure below. If the spring is non-linear, and the force F_s required to stretch the spring is $F_s = 2x_1^2$, represent the system in state space linearized about $x_1 = 1$ if the output is x_2. (*Hint:* Linearize the force before writing the differential equations)



30 marks