BIRZEIT UNIVERSITY

Faculty of Engineering and Technology
Department of Mechanical and Mechatronics Engineering
First Examination – Spring 2017

ENME 438: Control Theory	Student ID: _____
Date of Examination: 2/4/2017	Time duration: 90 minutes
Instructor: Eng. Sima Rishmawi	Total Marks: 100

This exam contains 3 pages (including this cover page) and 5 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.

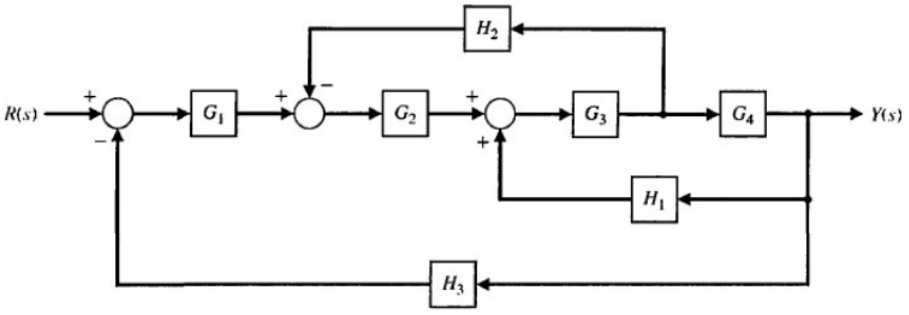
You may *not* use your books, notes, or any other reference on this exam, except for a one-sided A4 cheat sheet (to be handed in with your exam). You can use your own calculator only. Borrowing calculators is not allowed.

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:

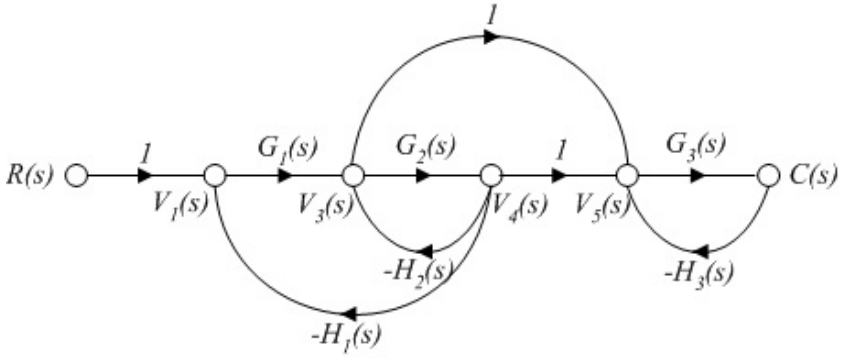
- **If you use a "certain principle" you must indicate this** and explain why the principle may be applied.
- **Organize your work**, in a reasonably neat and coherent way. Work scattered all over the page without a clear ordering will receive very little credit.
- **Mysterious or unsupported answers 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 $T(s) = \frac{Y(s)}{R(s)}$. Show all the steps in detail.



20 marks

2) Using Mason's Rule, find the Transfer Function $T(s) = \frac{C(s)}{R(s)}$ for the system shown in the Figure.



20 marks

3) Find the response $y(t)$ to a unit step input $u(t)$ using Laplace Transform.

$$\dot{\vec{x}} = \begin{bmatrix} -2 & 0 \\ -1 & -1 \end{bmatrix} \vec{x} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u(t)$$

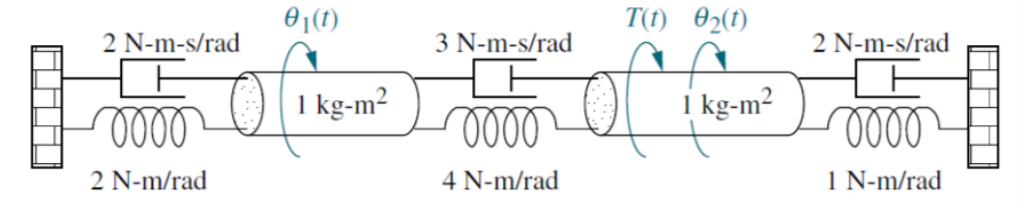
$$\vec{y} = \begin{bmatrix} 0 & 1 \end{bmatrix} \vec{x}$$

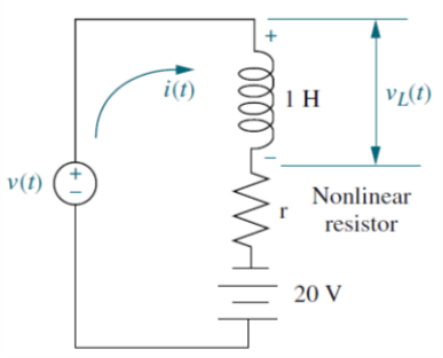
$$\vec{x}(0) = \begin{bmatrix} 3 \\ 0 \end{bmatrix}$$

20 marks

4) Represent the following system in State Space if the input is $T(t)$ and the outputs are $\theta_1(t)$ and $\theta_2(t)$.

20 marks





5) Find the Transfer Function $\frac{V_L(s)}{V(s)}$, for the electric network shown in the figure, which contains a non-linear resistor whose voltage-current relationship is defined by $i_r = 2e^{0.1v_r}$, where i_r and v_r are the resistor's current and voltage respectively. (*Hint*: Linearize the resistor's current about the equilibrium point $v_{r0} = 20\ V$)

20 marks