ECEN315 Test 2

- This test should be completed individually
- It is assumed to be open book
- Where you are asked to "describe" or "explain"; all answer should be written in your own words
- Where possible, show all working or explain how you got the answer you did (working and explanations are worth marks)
- You may hand write your answers or type them
- Bode paper is available on the ECEN315 wiki page (`https://ecs.wgtn.ac.nz/foswiki/pub/Courses/ECEN315_2020T1/Assignments/Blank_Bode-2.pdf`)
- You have a 24 hour window to complete the test, but it should not take longer than an hour to complete (you are allowed take longer)
- The test will be available from 11am on Wednesday the 17th of June
- When complete, please upload your answer sheet to the assessment system no later than 11am Thursday the 18th of June.

Student name: _____

Student number: _____

1. (24 points) **Root Locus Diagrams**

   (a) (5 points) Sketch the root locus diagram for the following systems, showing the asymptote's real axis intercept and angle where required:

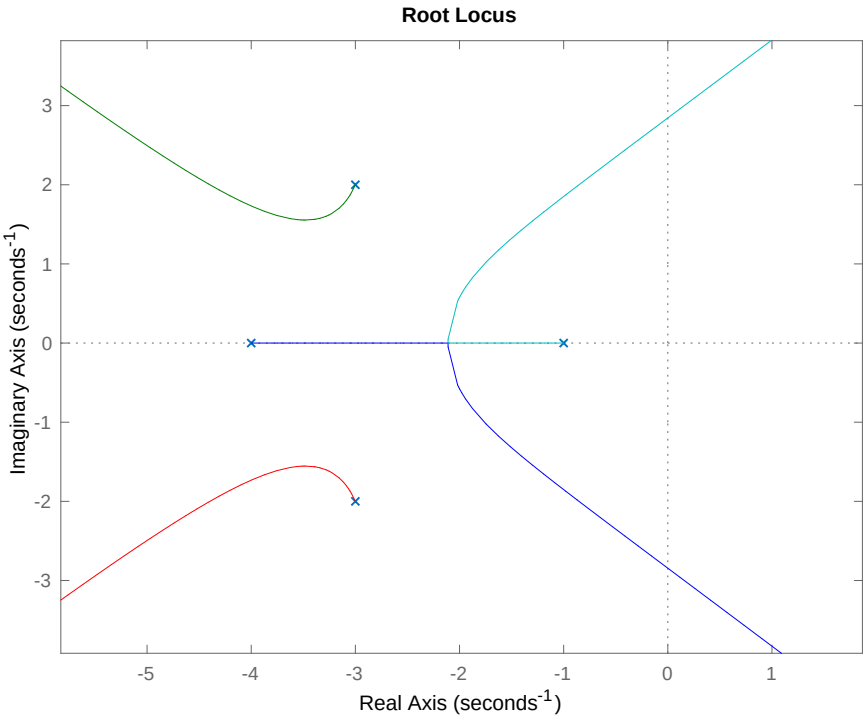
$$G_{(s)} = \frac{s^2 - 4s + 8}{s^2 + 4s + 3}$$

$$G_{(s)} = \frac{s + 4}{s(s + 6)(s + 3)(s + 1)}$$

   (b) (5 points) For the following transfer function, calculate the location(s) where branches of the root locus break out of and/or into the real axis (Note: calculating a derivative by hand is not required, but explain your methodology).

$$G_{(s)} = \frac{s^2 + 10s + 24}{s^2 + 3s + 2}$$

(c) (14 points) For the root locus diagram drawn below, calculate the point at which the root locus crosses the imaginary axis and calculate the closed loop gain at which this system will go unstable. (you may approximate the pole locations from the diagram)

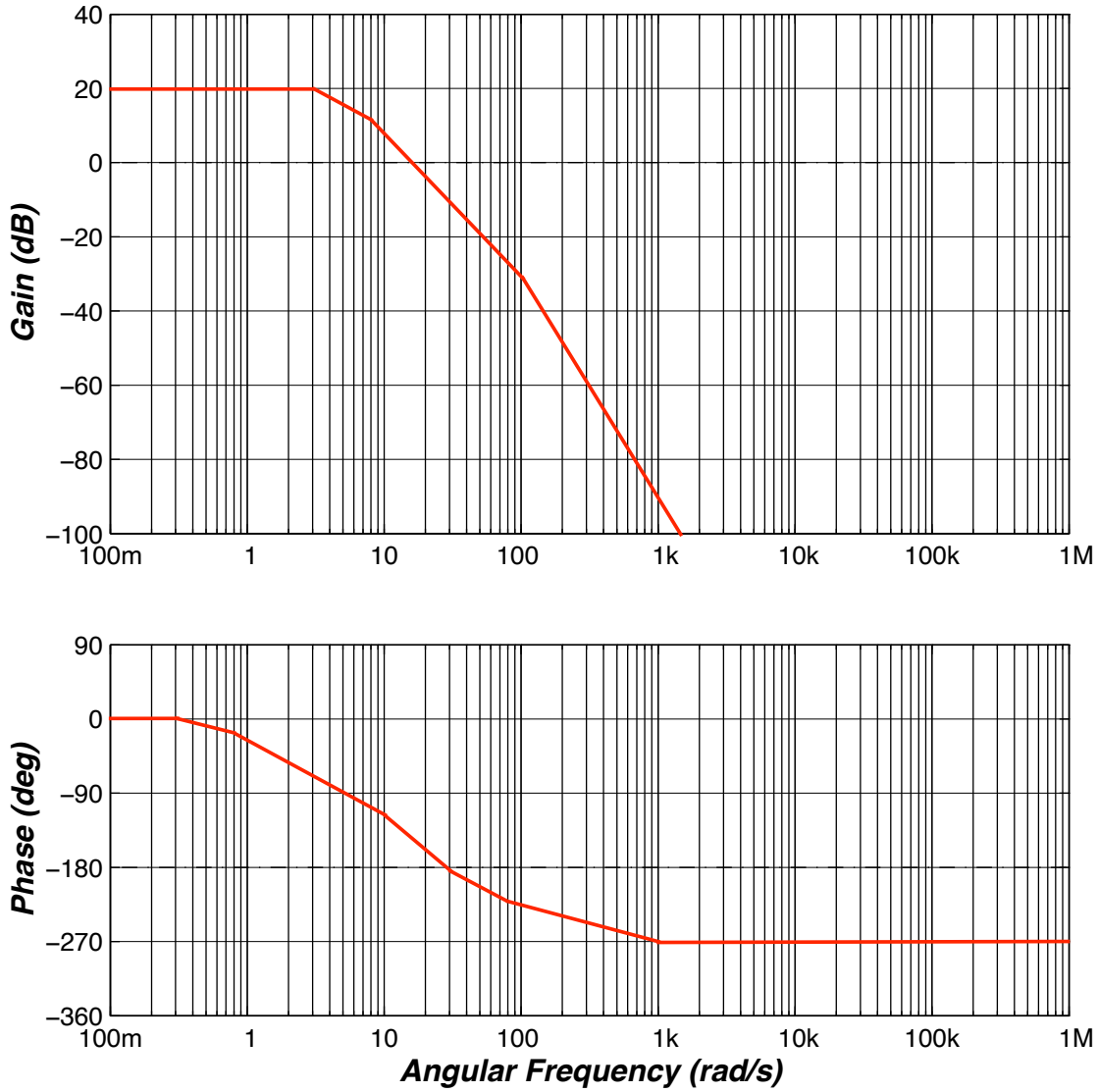


2. (36 points) **Bode Diagrams and Compensators**

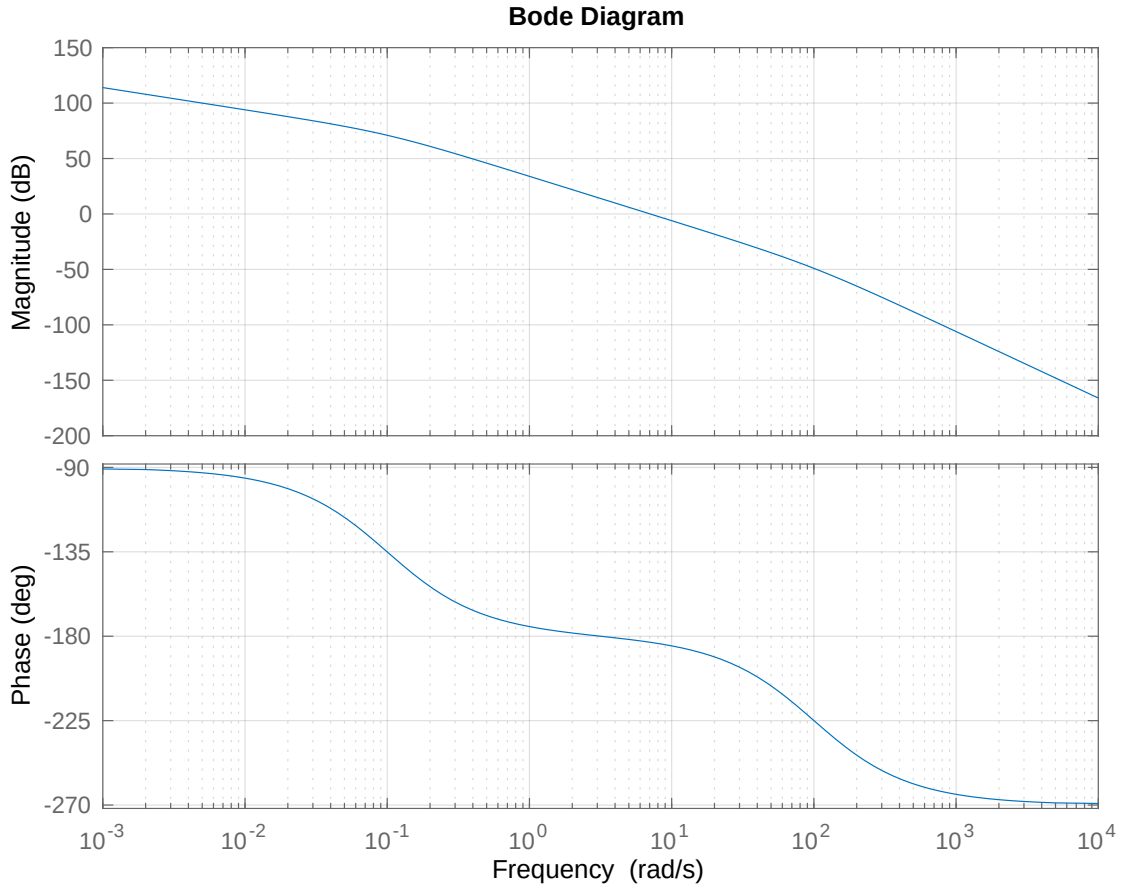
(a) (7 points) Sketch a straight line Bode approximation for the following transfer function. Ensure you show the individual components on the plot before you graphically add them.

$$G_{(s)} = \frac{s + 300}{s^2 + 10s}$$

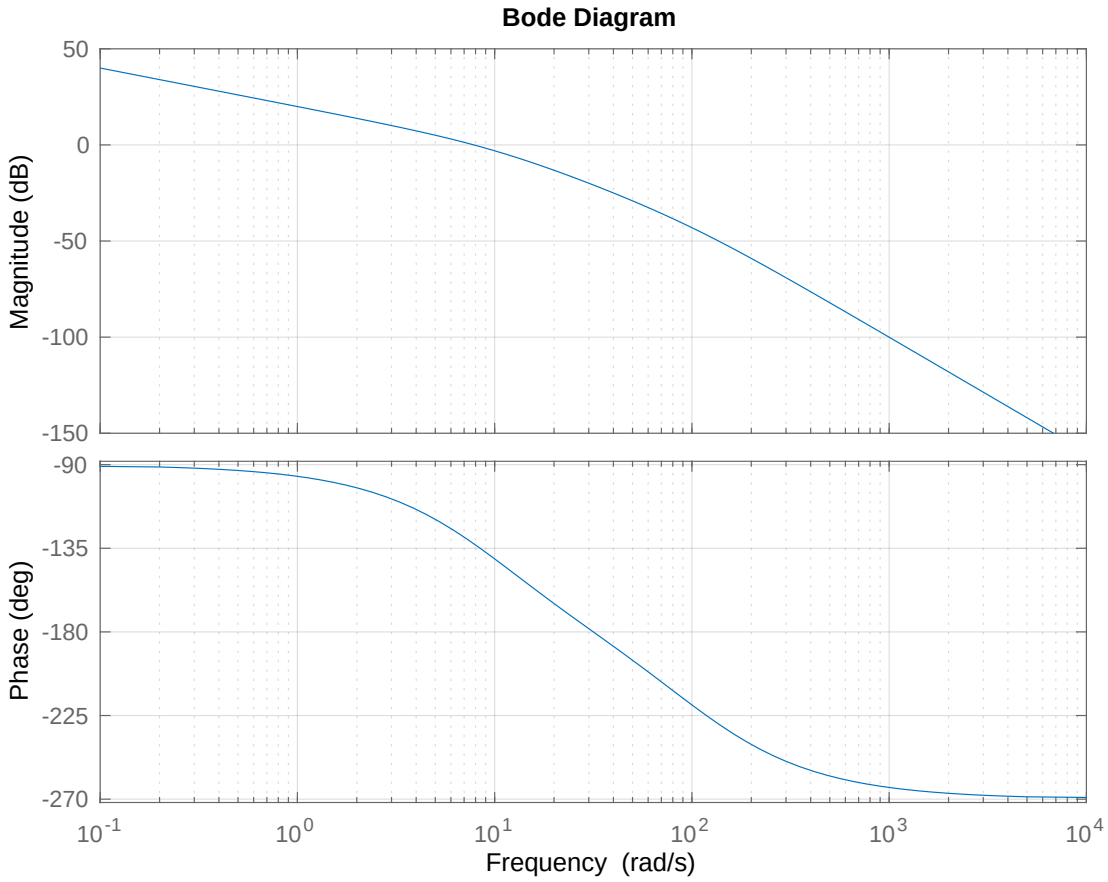
(b) (7 points) The following straight line Bode approximation has no right half plane roots, using the approximation, derive the transfer function that has been plotted. (hint: the gain of the transfer function is 24000)



(c) (5 points) For the Bode plot displayed below, give the type of the system and the steady state error for a step, ramp and parabolic input. Show or explain how you got your result.



(d) (5 points) For the Bode plot displayed below, give the approximate gain and phase margin, as well as the approximate damping ratio.



(e) (12 points) For the following plant, you are required to design a compensator that will ensure the system has a phase margin of 60 degrees. Sketch a straight line Bode approximation of the plant and compensator individually, then add the compensated system to show it meets the requirement.

$$G_{(s)} = \frac{20000}{s(s+100)(s+10)}$$