Marks

20 1a. How and why are OFFSET switches used on CNC machines?

b. What is meant by "constant surface speed" and how is it achieved on CNC machines?

c. How do you determine whether cutter compensation is to the left or right of a shape to be machined? Make a sketch.

d. What has to be changed to run a CNC program in Imperial Units on the CNC machine if the previous program was in metric units?

e. Give three reasons why the spindle is belt driven on a CNC lathe.

f. Why must the ACAD drawing imported into SmartCam have different layers for its geometry?

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6 2. The following sound pressure level measurements in dB were taken at the same locations as in lab V1 at a center frequency of 1000 Hz.

	Position 1	position 2	position 3	position 4	position 5	position 6
Lp [dB]	63	80	70	81	64	75

a. Calculate the mean sound pressure level for 6 points for a frequency of 1000 Hz.

b. Calculate the directivity index for points 1 to 5 in the plane x-y for a frequency of 1000 Hz, and sketch the polar plot of the directivity index.

c. Describe what you would hear if you walked around the sound source at a radius of 1 meter.

5 3.a. What is the main difference between static and dynamic unbalance?

b. What is the resultant unbalance in each case (radial force or rocking moment)?

c. Can an automobile engine crankshaft be balanced by static balancing?

d. Is balancing of a car tire in a garage (using spinning) static or dynamic? Explain your answer in a few lines.

5 4. List and describe briefly 5 changes that may be made in order to increase the fatigue life of a machine component. *(NOTE: Sargent and Yannacopoulos together could only come up with 4)*

a.

b.

c.

d.

e.

5 5. Why does iron corrode more rapidly when in contact with copper than when isolated?

6 6. A compact tension specimen (as used in lab E7) is tested in fatigue using loads from 10 kN to 100 kN in tension. The crack initially propagates in the "correct" mode i.e. perpendicular to the loading axis but later the crack path deviates and the crack eventually describes a curve with final fracture occurring at an angle of 45^{o} to the tensile axis. Suggest a possible reason for this behavior.

7 7. The system described in lab V3 has the following parameters.
Absorber mass $m_1 = 5$ kg
Main mass $m_2 = 0.05$ kg
Stiffness of main vibration system $k_1 = 12500$ N/m

a. Calculate the stiffness of the vibration absorber, k_2, required to reduce the amplitude of the main mass to zero. Assume that the frequency of the excitation, ω_1, is equal to the natural frequency of the main system alone and that of the absorber alone, that is $\omega = \omega_{n1} = \omega_{n2}$

b. If the length of absorber beam supplied, L', is 10% higher than that the design length, L, calculate the new stiffness of the absorber beam, k_2' and the new natural frequency of the absorber system alone, ω_{n2}'.

c. Without calculating the natural frequencies ω_1 and ω_2 what change in the natural frequencies of the total system would you expect.

d. What is a resonance frequency?

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6 8. In lab T-1, you studied the operation and performance of a Diesel engine. Consider the power stroke of the engine after combustion is complete. In each case, explain your answer.

a. Should it be modelled as an isentropic, polytropic or isothermal expansion?

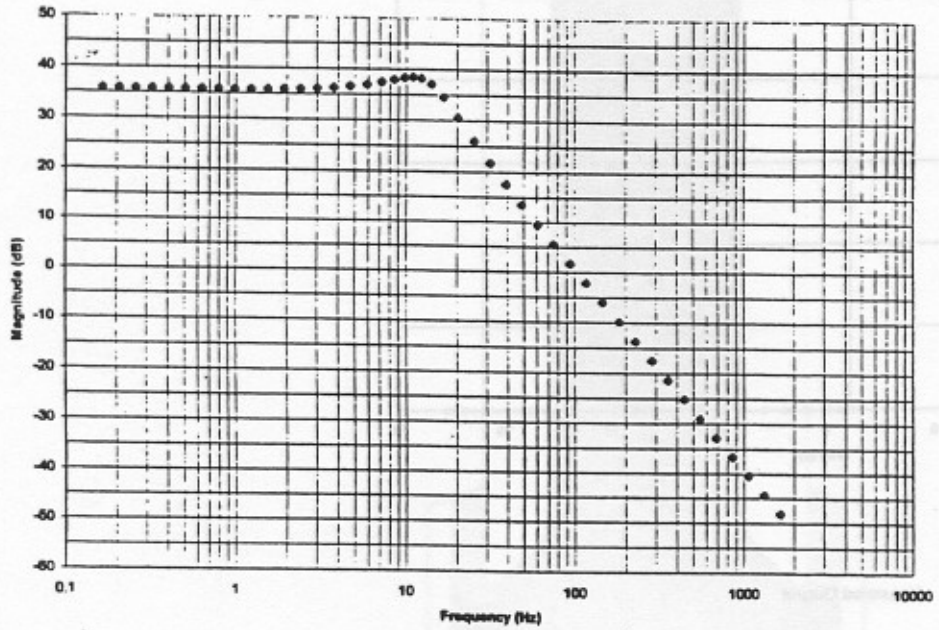
b. In which case is the calculated power generated a maximum?

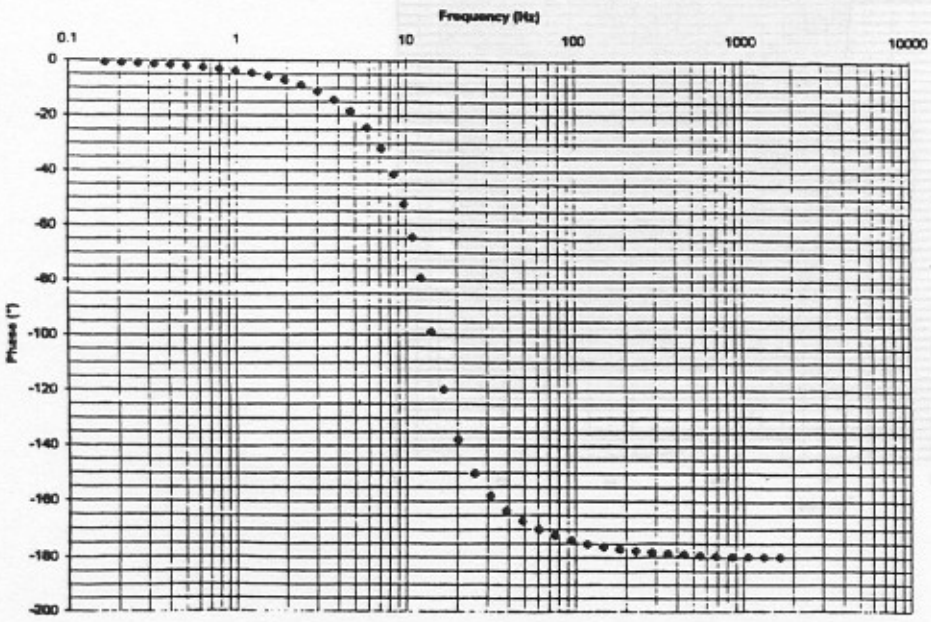
5 9. In lab T-2, you considered the operation of a converging-diverging nozzle with a normal shock wave located in the diverging section. Specify the location of the stagnation pressure p_{o2}.

5 10. Some types of failure involve a synergism between load and surface damage. One example is fretting fatigue which occurs when bolted or riveted joints are subject to relative motion. Briefly describe how you would redesign such joints to reduce fretting fatigue?

10 11. On the first day of your new job as a controls engineer, your boss has asked you to complete some work on a system. The only information the previous engineer left were the plots in the figure. You have determined from observation that the system is open loop with a voltage input. The output of the system was measured by a velocity transducer with a gain $K_v = 0.05$ Vs/mm.

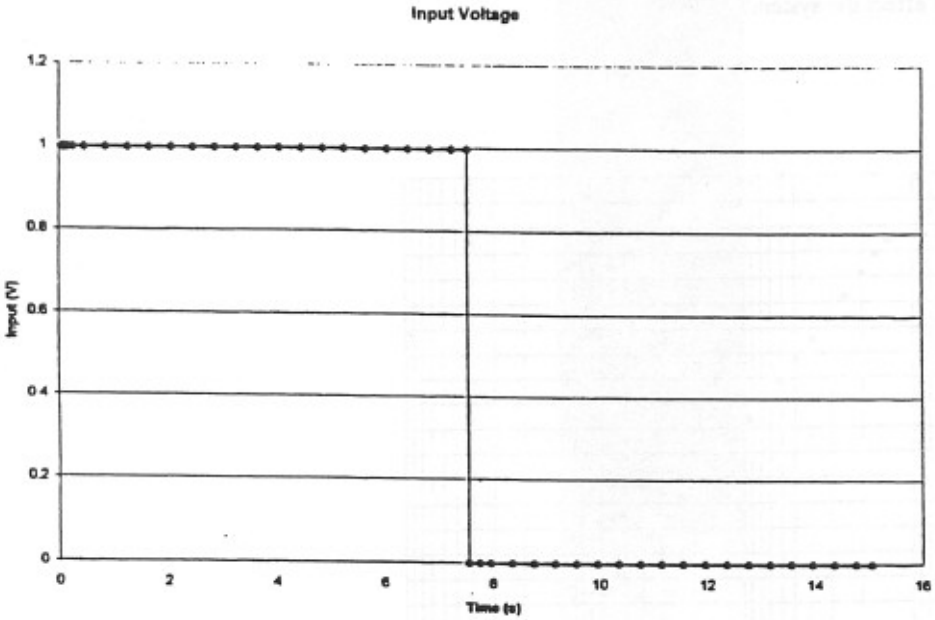
a. What order is the system?
b. Draw the open loop block diagram from the input voltage to the measured output using conventional parameter notation.
c. Find the parameters for the open loop system.
d. Derive the closed loop transfer function from the voltage input to the system velocity if velocity feedback is used to close the loop.
e. How does closing the loop affect the system?

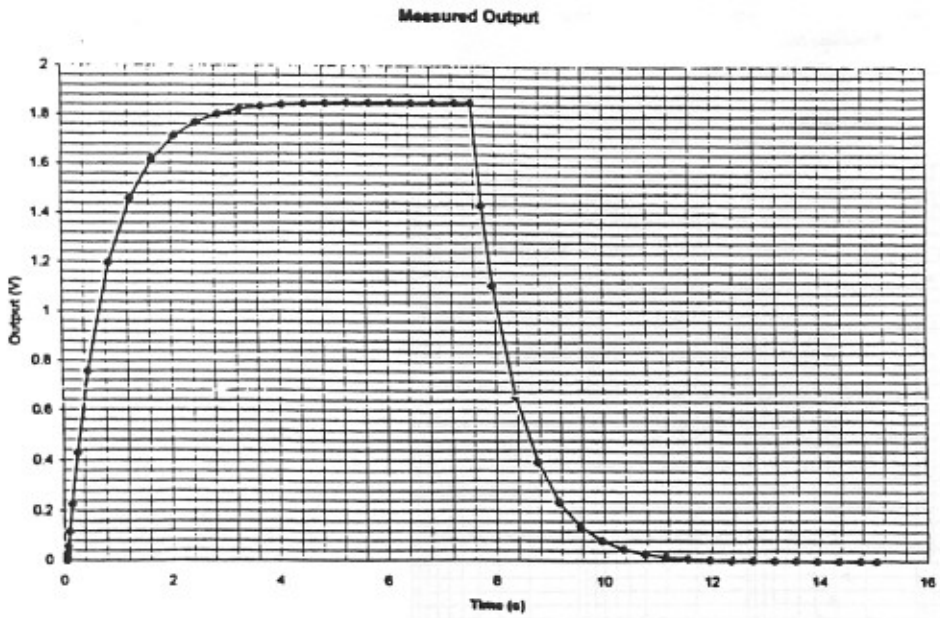




10 12. On the second day on your new job, your boss asks you to examine a different system. The input is voltage and the output is measured by a velocity transducer. You turn the machine on and observe the response shown in the figure. Assume a first order system.

a. Solve for the time constant using two different methods.
b. Solve for the steady state gain.
c. After reaching steady state the input voltage is turned off. Explain why the output velocity response appears as it does in the figure.





10 13. Consider the figure below. A PID controller is put in the system before the amplifier.

a. What is the job of a controller in any system?
b. The step responses for an unknown system are given in the figure with their respective gains. Use the Zeigler-Nichols method to approximate gains K_p, K_i, and K_d which would provide a good compromise between quick response and adequate damping.
c. If the response from the gains found in b) oscillates too much what changes can you make to reduce the oscillation?
d. If the response from the gains found in b) responds too slowly what changes can be made to improve response time?
e. If the response from the gains found in b) has excessive steady state error, what changes can be made to rectify the problem?

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