Marks

(3) 1. a) A student wrote the following sentence in the D1 Laboratory Report:
"The Krause, RR Moore, Bud, MTS and Warner Swazey machine's all produce variable fatigue stresses on it's specimen."
Examine this sentence for any errors, and re-write it correctly, in the space below.

(4) b) For the first testing machine in the above sentence, draw and label a shear and bending-moment diagram for the fatigue specimen used.

(6) 2. Some variability in procedures in the D2 tribological lubricity test may have caused large variations in the indicated oil film breakdown stresses.
List at least three factors that you feel may decrease the variability in these observed experimental results for a given oil sample in future tests.

3. Consider air flowing as an ideal gas through the converging/diverging nozzle used in laboratory T2 with the diverging section removed (i.e. only the converging section exists). The air is supplied from a plenum at 1000 kPa gauge and 310 K to the nozzle.

For air: $R = 287\ J\ kg^{-1}\ K^{-1}$, $k = 1.4$, barometer pressure = 100 kPa

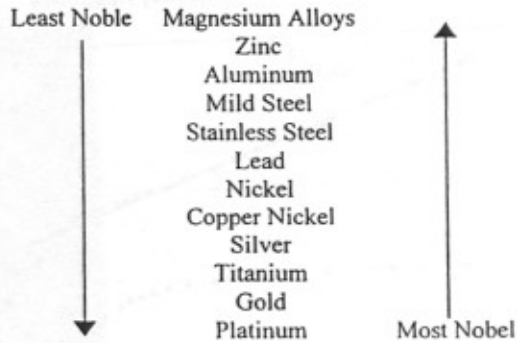
(12) (a) Show a plot of mass flow rate versus pressure ratio exit back pressure to plenum inlet pressure for the range 0 to 1.0.

(1) (b) Indicate on this diagram when the flow through the nozzle will be entirely subsonic and when there will be no shockwaves inside the nozzle.

(6) 4. Corrosion and Oxidation

You have decided to apply your knowledge of corrosion and oxidation to create a "colloidal silver solution". This solution is a common homeopathic remedy that acts as an antibiotic against bacteria, viruses, fungus, mold and yeast. To create the solution, you have decided to connect a silver coupon to a second coupon with both coupons being submersed in an ionic solution. What should the second coupon be? Justify your selection and indicate which coupon is considered to be the anode and which is the cathode.

The following galvanic series chart may be used in your selections



(7) 5. Fatigue Crack Growth

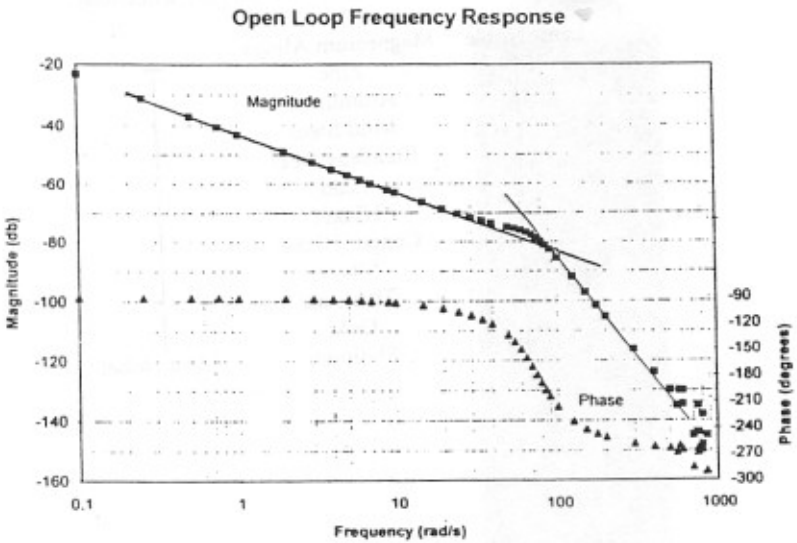
List seven factors that will affect the crack growth rate in a specimen.

6. Control System: Sinusoidal Response

A sinusoidal frequency response of an open loop system was obtained using a spectrum analyzer. The following Bode gain and phase diagrams were generated.

(5) a) Draw on the diagram the corresponding asymptotes, then determine the open loop transfer function for the system.

(2) b) Explain the difference between the experimental data and the asymptotes, especially at the break frequencies and at the high frequency range.



(4) 7. a) Describe briefly the function of a PID controller in a closed loop system.

(3) b) Explain how to implement such a PID controller on a digital computer.

(4) 8. a) What does a G50 command indicate to a CNC controller?

(3) b) The creation of an accurate CNC program requires a number of steps and revisions. One of the revisions that may be necessary after a first run is to evaluate and calculate new offset values. How do you find these offset values?

(3) c) After a workpiece on a CNC-Lathe has been machined the inspection shows that **all** dimensions in the Z-direction are 1mm too short. The programming (drawing) dimensions used in Z-direction are checked and no mistake was found. What could be wrong?

(3) d) What options do we have to describe a roughing cycle "**TurnRough**" in SmartCam? Name at least three.

(4) e) The chips of a ductile material machined on a CNC lathe, at half power consumption, are long continuous strands. These long strands will be very difficult to handle and will not only be a safety hazard but could become tangled in the workpiece and cutting tool. Using a tool with a chipbreaker did not solve the problem. What can be done?

(3) f) Anytime a drill moves to its startpoint in the X-direction, which is at the center of the spindle, the drive motor of the CNC machine stalls. Why?

(2) 9. a) Determine the type and order of the system shown in Fig. 9.1.

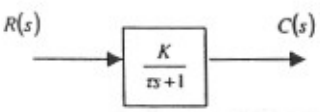


Figure 9.1: System

The response of this system to a step input of magnitude 10 is shown in Figure 9.2.

(5) b) Obtain K and τ from Figure 9.2.

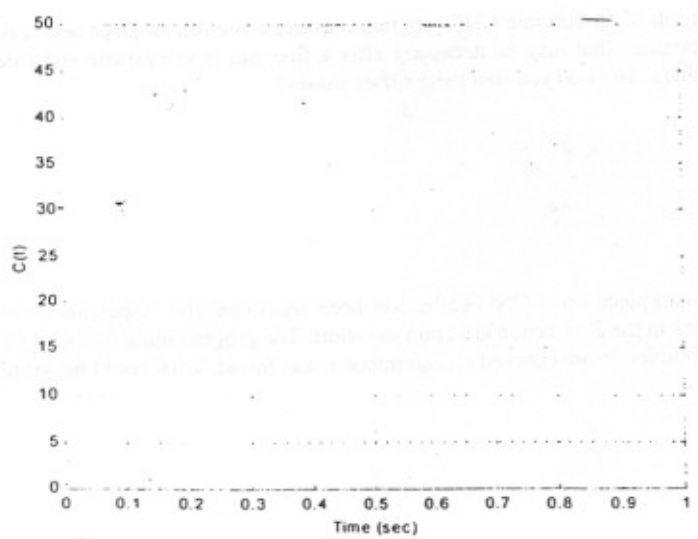
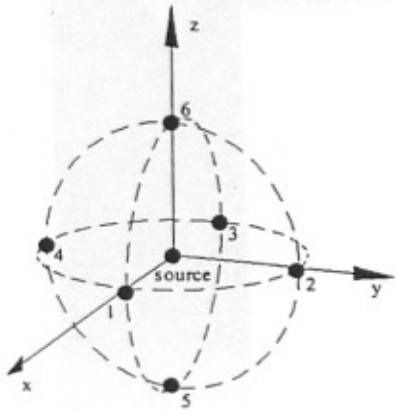


Figure 9.2: Step Response

(4) 10. a) Sound power and sound pressure calculations are often carried out assuming a free field. A free field can be verified if a 6 dB drop in sound pressure level is measured for each doubling of distance from a source. Show mathematically why this is the case.

(6) b) Sound pressure measurements were taken at points which define a sphere (radius is 2m) about a source as shown in Figure 10.1. The measurements were taken at a center frequency known to dominate the sound power spectrum for the machine. Given the following values for the sound pressure level determine the mean sound pressure level, the sound power level, and plot the directivity index in the x-y and x-z planes for this center frequency.



Point	Lp [dB]
1	80
2	81
3	77
4	79
5	79
6	71

Figure 10.1 Locations of Sound Pressure Level measurements.

(10) c) To cancel the vibration in a mechanical system being operated at its natural frequency, an absorber can be added. This situation is shown schematically in Figure 10.2. An ideal absorber would have the same natural frequency as the main system. If the main mass is 7 kg and the main spring has a stiffness of 13 000 N/m:

i) Calculate the stiffness of the spring for an ideal absorber of 0.5 kg mass.

ii) Calculate the displacement of the main mass when the system is operated at its natural frequency by a force, F_0, of 150 N and the absorber stiffness is 5% less than was calculated to be ideal in part i).

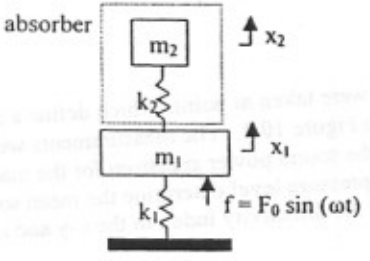


Figure 10.2 Mechanical system with an absorber.