# UNIVERSITY OF SASKATCHEWAN
## COLLEGE OF ENGINEERING
## DEPARTMENT OF MECHANICAL ENGINEERING
## MECHANICAL ENGINEERING LABORATORY III
## ME 418.3 LAB EXAM

**TIME: 3 Hours**
**Log books, lab manuals and M Lab reports permitted**

**December 6, 2004**

Name: _____

Student Number: _____

Signature: _____

Please answer each question in the space provided. You may use the back of each sheet if required.

| Question | Marks | Score |
|----------|-------|-------|
| 1 | 8 | |
| 2 | 8 | |
| 3 | 5 | |
| 4 | 10 | |
| 5 | 10 | |
| 6 | 13 | |
| 7 | 10 | |
| 8 | 5 | |
| 9 | 6 | |
| 10 | 7 | |
| 11 | 18 | |
| **Total** | 100 | |

*Marks*

(8)    1.    Consider the converging-diverging nozzle used in the T2 laboratory. The nozzle is supplied by a plenum chamber ($P_o$=1 MPa and $T_o$=400 K) and the back pressure $P_B$ is adjusted to position a normal shock at the exit plane.

       (a)    Calculate the static temperature just downstream of the shock.
       (b)    Calculate the mass flow rate through the nozzle.
       (c)    Calculate the mass flow rate if the stagnation pressure in the plenum chamber were doubled.
       (d)    Calculate the mass flow rate if the back pressure were halved ($P_o$ returned to 1 MPa).

(4)    2. (a) Name the fatigue testing machines examined in laboratory D1 that used cantilever loading to stress their specimens.

*Marks*

**(4)**   2. (b)  Why was pack carburizing followed by tempering effective in raising the endurance strengths
          of the second group of A36 steel fatigue specimens?

**(5)**   3.  The following three oils were tested in the Cannon-Fenske Viscometer:

           Dextron III Automatic Transmission Fluid
           SAE 0W-40 Motor Oil
           SAE 10W Motor Oil

        (a) Which oil would have the highest viscosity at 100°C ? (1 mark)

        (b) Which one would have the lowest viscosity at 40°C ? (1mark)

        (c) Which oil would possess the lowest viscosity index? (1 mark)

        (d) How would the viscosity of SAE 10W be specified if it was to be packaged as a hydraulic
            fluid?  (2 marks)

**(10)**   4. (a)  An operator in a textile mill is operating five machines. The individual sound pressure
          level of each of the machines at his position are 95, 90, 92, 88 and 82 dB, respectively.
          What is the total sound pressure level at his position due to all five machines? (2 marks)

        (b) Determine the average sound pressure level for the following set of measured values
            $L_{p1}$=96 dB, $L_{p2}$=100 dB, $L_{p3}$=90 dB and $L_{p4}$=97 dB. (2 marks)

        (c)  The sound pressure level measured when a machine is operating is 94 dB.  The
             background level is 85 dB.  Determine the round pressure level of the machine alone.
             (2 marks)

        (d) Calculate the mean sound pressure level for a sound with a mean acoustic pressure of
            2.5 Pa. (2 marks)

(e) Determine the sound power of a machine whose sound power level is 125 dB (2 marks)

**(10)**    5. (a)   Why is vibration control useful and what common vibration control techniques are used in industry? (2 marks)

5. (b)   To cancel the vibration in a mechanical system, an absorber can be added. An ideal absorber would have the same natural frequency as the main system. Calculate the mass of an ideal absorber for a system whose natural frequency is 25 Hz given that the absorber spring stiffness is 3800 N/m. (3 marks)

5. (c)   If a main system/absorber combination is implemented with a main mass of 1.2 kg, a main spring stiffness of 29600 N/m, an absorber of mass of 0.15 kg and an absorber spring stiffness of 2870 N/m, what are the two new resonant frequencies and the amplitude of vibration for an exciting force of 50 N when operated at the main system natural frequency? (5 marks)

**(13)**    6. (a)   List five ways of improving resistance to fatigue failure. (5 marks)

6. (b)   An alloy forging steel has a specific minimum proof stress, $\sigma_y = 800$ MPa and a guaranteed minimum fracture toughness, $K_{Ic} = 120$ MPA m$^{1/2}$. Calculate the minimum test piece dimensions needed to carry out valid tests to check the toughness values. (4 marks)

6. (c)  Sketch a typical concentration cell and label the parts, indicating the direction of electron flow. (4 marks)
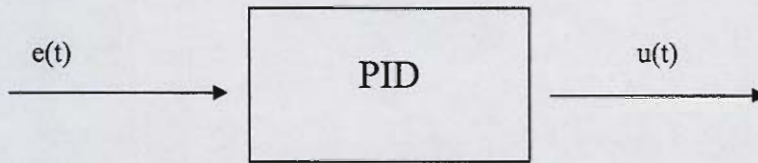
### *Marks*

**(10)**    7.    An open loop system that is known to be first order is subjected to a step input of magnitude 2.8 V. The system output displacement ($m$) is measured using a linear potentiometer transducer having a sensitivity of 12 V/$m$. The measured system response to the step input is shown below. Determine the system transfer function and change in displacement due to the step input.
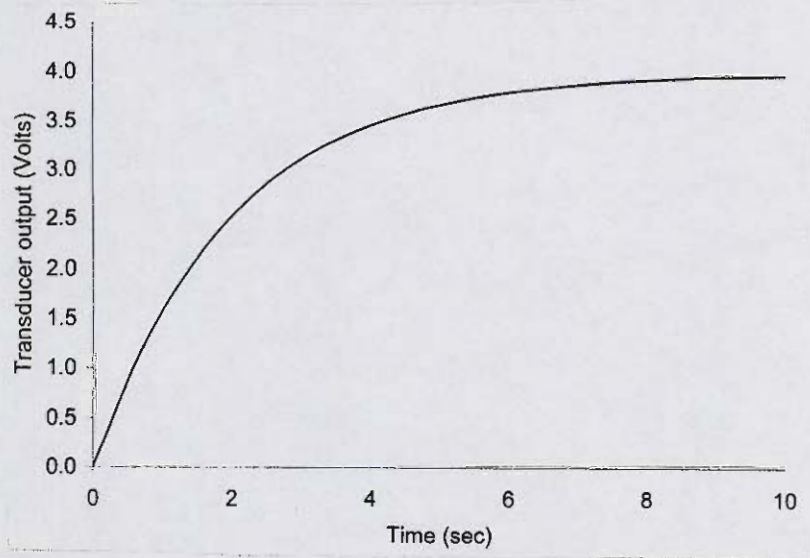


**(5)**    8.    In the electromechanical system laboratory, would the presence of gear backlash mainly affect system damping, accuracy or both of these parameters? Explain your answer.
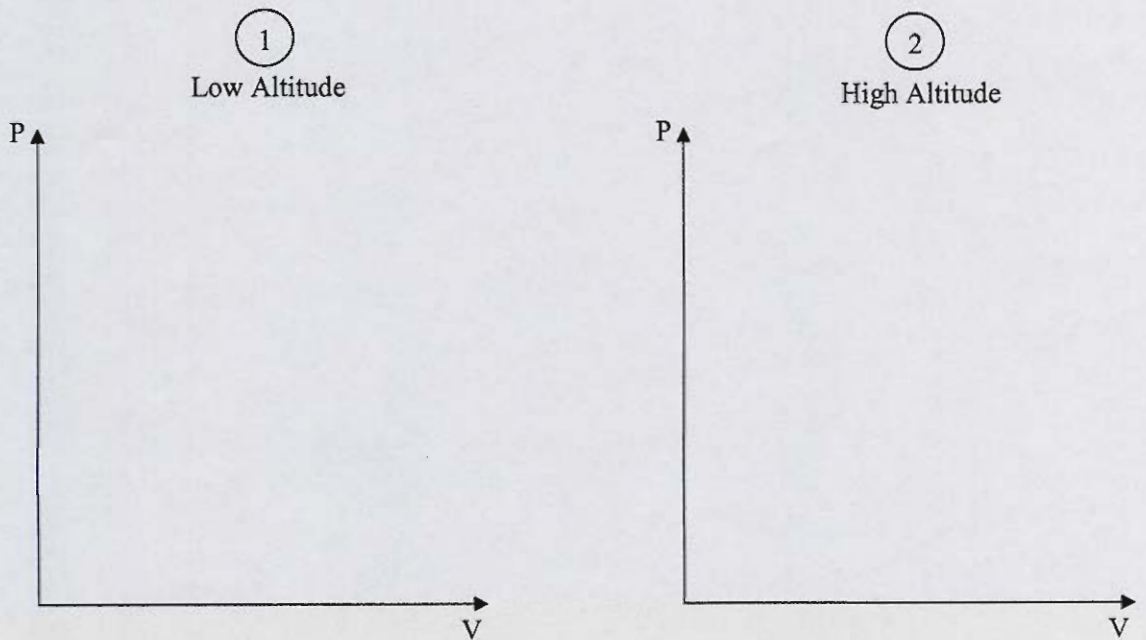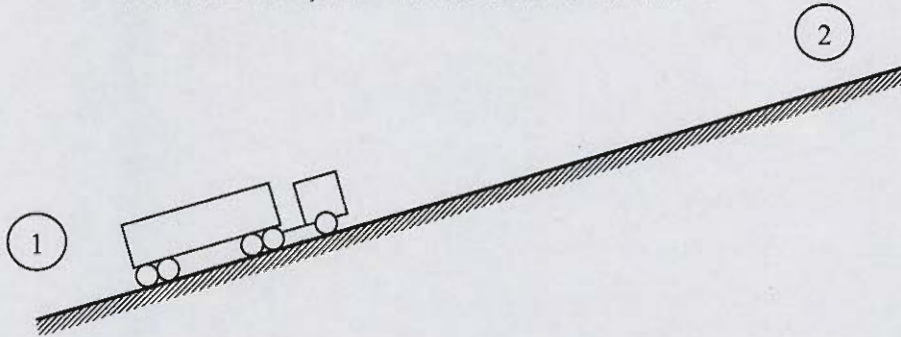
**_Marks_**

(6)     9.



The above PID controller is subjected to an input signal e*(t)*, shown below. Sketch the general shape of the output component of u(t) associated with each of the P, I and D components up to a time of 2.0s in the space provided on the graph below.
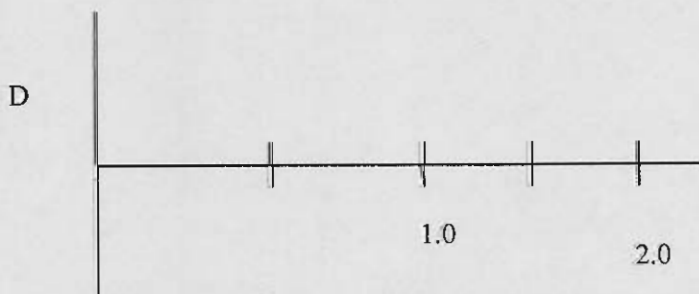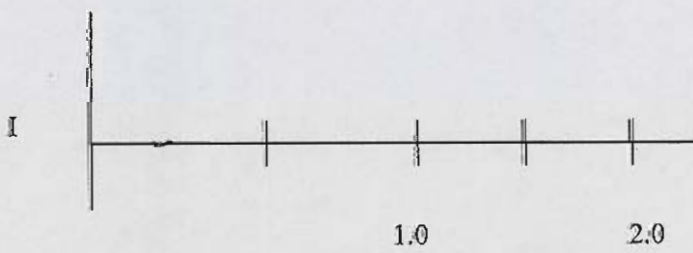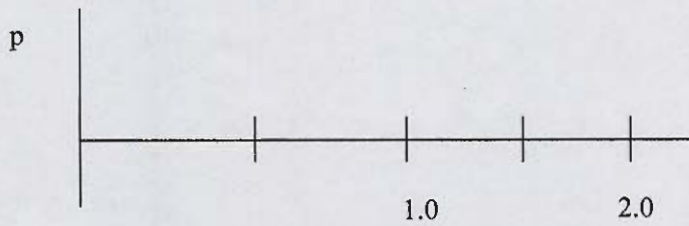
*Marks*

(7)    10.    A truck with a diesel engine drives from a port at sea level up through a mountain pass at a
high altitude, shown at positions 1 and 2 in the diagram. The mass flow rate of diesel fuel
into the engine remains constant as the truck travels from low altitude to high altitude.
Sketch typical Pressure-Volume diagrams to compare the low altitude case at 1 to the high
altitude case at 2. Show all four strokes. Comment on the effect of altitude on the
Indicated Power, and what causes the difference.



$\textcircled{1}$
Low Altitude

$\textcircled{2}$
High Altitude

*Marks*

**(18)** 11. (a)  <u>Mastercam</u>. Which button do you have to select in the "Lathe Face Control Box" for a roughing facing tool to enter the final length of the workpiece into the real table #10? (3 marks)

(b)  <u>Mastercam</u>. In the "Lathe Cutoff Parameters Control Box", a value for the $\underline{X}$ Tangent Point has to be set. What does this value represent? (3 marks)

(c)  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 off set values. How do you find these offset values? (3 marks)

(d)  How can you reduce chatter (vibration) during machining of a surface on a CNC-lathe? Name three methods you would try. (6 marks)

(e)  What is the purpose of a "dry run" on a CNC-lathe? (3 marks)

# END OF EXAM