Name: _____

ID #: _____

University of Saskatchewan
Department of Mechanical Engineering
ME 478 – Introduction to Fire Protection Engineering

October 29, 2004	Mid Term Exam	90 minutes

100 Points Total

Closed Book Exam - students are permitted to bring one 8.5" x 11" sheet into the exam for formulae and other information; no formulae or other information may be brought into the exam in the memory of programmable calculators or any other electronic storage device

For numerical questions – please show all work in the space provided.
For descriptive questions – please answer each question in a concise and clear fashion in the space provided.

Question 1

a) Canada is set to introduce objective-based building codes in 2005. Briefly describe three ways in which this development is expected to affect the practice of fire protection engineering in Canada. (5 points)

b) Use the fire triangle to briefly describe the phenomenon of backdraft. (5 points)

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c) Briefly explain the difference between a pre-mixed and a diffusion flame. Provide one practical example of each of these types of flames. (5 points)

d) Briefly discuss two reasons why design methods used in fire protection engineering are considerably less advanced than design methods used in other disciplines, such as structural engineering. (5 points)

e) To celebrate the 100th anniversary of the UofS in 1907, it is announced that a new Mechanical Engineering building will be built. Give two examples of fire safety issues in the construction and operation of the new building that would be addressed by the National Building Code (NBC) and two examples of fire safety issues that would be addressed by the National Fire Code (NFC). (5 points)

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Question 2

a) Calculate the adiabatic flame temperature of a mixture of methane and air, initially at 25ºC, assuming that dissociation does not occur. The equivalence ratio for this mixture is 0.6. Compare this adiabatic flame temperature to actual flame temperatures. (10 points)

b) What would happen if the equivalence ratio for this mixture was reduced to 0.4? (5 points)

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Question 3

a) Given the following data from a cone calorimeter test of a specimen taken from a sofa, calculate the heat release rate at time t_3, using the oxygen consumption calorimetry method. Consider both the concentrations of O_2 and CO_2 and assume that the product of density and heat of combustion is 17,200 kJ/m^3. (10 points)

Time	Volumetric Flow Rate (m^3/s)	CO_2 (by volume)	O_2 (by volume)
t_1	2.0	0.0%	20.95%
t_2	2.0	0.5%	20.7%
t_3	2.5	3.0%	17.0%

b) Briefly describe one advantage and one disadvantage of using the cone calorimeter instead of a full-scale fire test to study the fire behaviour of this sofa. (5 points)

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Question 4

Firefighters are called to a fire in an industrial building. When they arrive, they immediately begin to spray water on the outside of one wall of the burning building, which is 10 m high by 50 m wide and completely covered in flames, which project 2.0 m away from the wall. It can be assumed that the temperature of the flames is 1000ºC, and that the fire can be treated as a blackbody.

In order to provide the maximum coverage of water, the firefighters wish to stand as close as they can to the center of the base of this exterior wall. However, even with protective clothing, the maximum heat flux that they can be subjected to is 14.0 kW/m^2.

a) Based on this criterion, how close should firefighters stand in front of the center of the base of the wall? (10 points)

b) How do you think that your answer in part (a) would compare to an estimate made by treating the fire as a point source? (5 points)

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Question 5

a) 100 mm thick pieces of polymethylmethacrylate (PMMA) are often used when calibrating the cone calorimeter. Estimate the temperature increase at a depth of 10 mm from the surface of a piece of PMMA after a 280 s exposure in the cone calorimeter to a heat flux of 40 kW/m^2. (10 points)

b) Briefly explain how you could increase the accuracy of your estimate of the temperature in part (a). (5 points)

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Question 6

A test room used in ISO 9705 full-scale room fire tests is 2.4 m by 3.6 m by 2.4 m high with a single door 0.8 m by 2.0 m high. A 100 kW fire is placed in the back corner of the test room as an ignition source. The ambient temperature is 25ºC. On the center of the ceiling of this test room is a sprinkler that has a temperature rating of 68ºC and a RTI of 100 $m^{1/2}s^{1/2}$.

a) Calculate the activation time for this sprinkler if the ISO 9705 test is run using only the 100 kW ignition source. (10 points)

b) Which sprinkler parameter is used to specify the time response of a sprinkler? If the activation time for the sprinkler in this question must be reduced by 50%, what must the value of this sprinkler parameter be changed to? (5 points)