IMAM MOHAMMAD IBN SAUD ISLAMIC UNIVERSITY

DEPARTMENT OF MECHANICAL ENGINEERING

FINAL EXAMINATION – Spring 2021 (Online)

ME 441: INTERNAL COMBUSTION ENGINES

Instructions:

1. This is an open book and open notes exam.

2. The exam must be taken through the Blackboard system because the attendance will be recorded through this system and final exam copies must be attached to the Blackboard. Files may also be sent to email as a backup. Files received without name and student ID will not be graded.

3. The duration of the exam is 2.5 hours
   + 5 minutes given for submission through the Blackboard
   +10 minutes given for submission through the email

4. The exam is to be solved on A4 sheets of paper. Attach a cover page and put your name, student ID on it. Put page numbers in sequence. Once finished scan the whole exam and submit it as a single pdf file through the Blackboard and email.

   (i)   Send the pdf file as an attachment through Blackboard
   (ii)   Email the pdf file to smfhasani@hotmail.com

5. Test files received via email after the 10-minute submission time will not be accepted and given a zero in the final exam.

WARNINGS

6. **Exam files received without names and student ID's will not be graded.**

7. **YOU ARE <u>NOT ALLOWED</u> TO SEEK ANY HELP RELATED TO THE TEST FROM ANY OTHER PERSON**.

8. **IF TWO OR MORE SOLUTIONS ARE FOUND EXACTLY IDENTICAL, THEY WILL BE SCRUTINIZED AND WILL BE FORWARDED TO THE DEAN FOR FURTHER ACTION. IF FOUND GUILTY, IT IS POSSIBLE THAT ALL THOSE INVOLVED MAY BE GIVEN A ZERO IN THE EXAM WITHOUT BEING GIVEN ANOTHER CHANCE.**

***** Questions to begin from the next page *****

1. Give short and to the point answers to the following questions: (20 points)
   [**You may answer the questions in any sequence but do mention against each answer the proper reference of the question whether you are answering (a) or (b) or (c) etc.]**

(a) If the crank shaft in a 2-stroke, 2-cylinder SI motorcycle engine rotates at 2500 rpm. How many power strokes will be executed by this engine in one-minute?

(b) In a conventional 4-stroke SI engine, if the crank shaft rotates at 1500 rpm, at what speed must the cam shaft rotate?

(c) In modern day cars, the old carburettor system has been replaced by the EFI system. What are the two main types of EFI system?

(d) What is the function of a choke valve in a carburettor system?

(e) In actual engine cycles which technique is usually employed to reduce the time loss factor?

(f) Which type (series) of fuels are considered good antiknock fuels for CI engines?

(g) What is the difference between Fire point and Flash point? Which one is higher?

(h) What kind of emission losses are reduced by the exhaust gas recirculation system?

(i) What kind of emission losses are reduced by the PCV valve?

(j) What kind of emission losses are reduced by the catalytic converter?

2. An 8-cylinder, 4-stroke gasoline engine is tested on a dynamometer. The engine and the dynamometer has the following specifications:

Engine bore = 9 cm

Stroke = 8 cm

Compression ratio = (7 + Y) where Y is the last (right most) digit of your student ID

Engine test speed = 4000 rpm

Force read on dynamometer scale = (400 + XY) Newton where XY are the two right most digits of your student ID.

Dynamometer arm = 54 cm

Calorific value of the fuel = 44 MJ/kg

Fuel flow rate = 0.4 kg/min

Air flow rate = 6 kg/min

Air inlet temperature = 300 K

Air inlet pressure = 1 bar

R_{air} = 287 J/kg.K

Find (i) the brake power delivered (ii) the brake mean effective pressure (iii) the brake specific fuel consumption (iv) the brake specific air consumption (v) the brake thermal efficiency (vi) the volumetric efficiency, and (vii) the air-fuel ratio.

(20 points)

Sample student ID: 4 3 4 0 0 2 9 1 5

X

Y

So as per sample ID:

Y=5   and   XY=15

3. Liquid octane (C_8H_{18}) enters the combustion chamber of a gas turbine steadily at 1 atm and 25°C, and it is burned with air that enters the combustion chamber at the same state. If the reaction is stoichiometric and the products leave the combustion chamber at a pressure of 1 atm and a temperature of 2400 K, determine the entropy generated (S_{gen}) in the reaction. [R_u = 8.314 kJ/kg.K]

(20 points)

4. In a SI engine working on the ideal air-standard Otto cycle, the compression ratio is (5.5+Y). The pressure and temperature at the beginning of the compression are 1 bar and 27°C respectively. The peak pressure is (30+3*Y) bar. Determine (i) the pressure and temperature at the remaining points of the cycle, (ii) the air-standard efficiency, and (iii) the mean effective pressure. Assume ratio of specific heats for air = 1.4.

(20 points)

[Y is the last digit of your student ID]

Sample student ID: 4 3 4 0 0 2 9 1 5

Y

So as per sample ID:

Y=5

5. A six cylinder, 4-stroke gasoline engine develops a brake power of 180 kW. A Morse test was conducted on this engine and the brake power (kW) obtained when each cylinder was made inoperative by short circuiting the spark plug, is shown in the following table:

Condition	Brake Power (kW)
All firing	180
1st cylinder	147.7
2nd cylinder	149.2
3rd cylinder	148.4
4th cylinder	147.5
5th cylinder	148.8
6th cylinder	147.5

The test was conducted at a constant speed of 2200 rpm. The bore and stroke of the engine are 89 mm and 96.4 mm respectively. Find the indicated power, friction power, mechanical efficiency, the indicated mean effective pressure, and the brake mean effective pressure when all the cylinders are firing.

(20 points)