Department of Mechanical Engineering
Chittagong University of Engineering and Technology (C U E T)
Level 4, Term-II, Examination 2023

Course No: ME 411	Full Marks: 210	Time: 03 hours
Course Title: Applied Thermodynamics	Date: 13/ 05 / 2025	

The figures in the right margin indicate full marks. The questions are of equal value. There are 04 questions in each section. Answer any 03 questions from each section. Use separate script for each section.

Section: A

			Marks
1	a)	Two automobile engines have the same total displacement volume and the same total power produced within the cylinders. List the possible advantages of V6 over a straight line (in line).	09
	b)	What is the friction power for IC engine? How this power can be reduced?	09
	c)	In a test of single cylinder engine with bore 30 cm, stroke 45 cm and working on 4-stroke cycle, the following observations were made: Duration of trial = 1 hour, total fuel consumption = 8 kg, heating value of fuel = 45000 kJ/kg, total revolutions made = 12000, indicated mean effective pressure = 6 bar, brake load = 1500 N, torque arm = 92 cm. Find, indicated power, brake power, mechanical efficiency, thermal efficiency.	17
2	a)	Differentiate between constant volume combustion and constant pressure combustion processes. Give examples.	10
	b)	How combustion efficiency of an IC engine is defined? Show the effect of fuel-air equivalence ratio (φ) on spark ignition combustion efficiency.	10
	c)	Calculate the higher heating value of $CH_4(g)$. Consider bomb calorimeter is used. Given standard enthalpies of formation of $CH_4(g)$, $CO_2(g)$, $H_2O(g)$ and $H_2O(l)$ are -74.87 MJ/kmol, -393.52 MJ/kmol, -241.83 MJ/kmol and -285.84 MJ/kmol, respectively. Given T_o = 298.15 K and $\bar{R}$ = 8314.3 J/kmol.K	15
3	a)	Explain the knocking phenomena in SI engine and CI engine.	13
	b)	Explain the different combustion stages of CI engine.	12
	c)	Why lowering the compression ratio in CI engine increases the knock tendency?	10
4	a)	A 4-stroke cycle engine may or may not have a pressure boost (supercharger, turbocharger) in the intake system. Why must a 2-stroke cycle engine always have an intake pressure boost?	10
	b)	Explain the effect of delayed charging on IC engine volumetric efficiency.	10
	c)	A diesel engine operating on the 4-stroke cycle is to be deigned to operate with the following characteristics where the mean conditions are: 1 bar and 25°C, brake power = 254 kW, volumetric efficiency = 0.79, brake specific fuel consumption = 0.27 kg/kW.hr, air-fuel ratio = 17:1, speed = 1525 rpm. Calculate the required engine capacity and brake mean effective pressure. Heat of combustion of diesel fuel = 43000 kJ/kg. R_a = 287 J/kg.K.	15

Section: B

5	a)	Why the cooling of IC engine is necessary? Explain how cylinder size affects engine heat transfer?	09
	b)	Explain the effects of load on NO_x emission from CI engine.	10
	c)	Estimate heat loss of 12 cylinder gasoline engine operating at 590 kW, fuel-air ratio = 0.08, inlet air temperature = 27°C, gas temperature = 400°C. The engine is of 145 mm bore and 145 mm stroke, brake thermal efficiency = 0.25. Calculate heat loss per unit piston area, ratio of heat loss to heat of combustion. Heat of combustion of gasoline fuel = 42 MJ/kg, $\mu_g = 32.5 \times 10^{-6}$ kg/m-s and k_g = 0.12 kW/m-K.	16
6	a)	Explain briefly the difference between direct and indirect cycle for gas turbine. Derive a relation between compressor and turbine outlet temperature for getting maximum specific power.	18
	b)	A gas turbine inlet receives air at 1 bar and 300K and compresses it adiabatically to 6 bar. The compressor efficiency is 90% where the fuel has heating value of 44000 kJ/kg and fuel-air ratio is 0.017. The turbine efficiency is 92%. Calculate the work of the turbine and compressor and also find the thermal efficiency. For air c_p = 1.005 kJ/kg-K, γ = 1.4. For products of combustion, c_p = 1.47 kJ/kg-K, γ = 1.33.	17
7	a)	What is photovoltaic device? Explain P-type silicon and N-type silicon and working principle of photovoltaic device.	18
	b)	What is fuel cell? Explain working principle of $H_2 - O_2$ fuel cell.	17
8	a)	How turbofan engines are aerodynamically more efficient than turbo propeller engine? How energy produced from turbines is distributed in these engines?	12
	b)	Differentiate between ramjet and rocket. Enlist the advantages of ramjet.	08
	c)	A turbojet engine flying at a speed of 850 km/hr consumes air at the rate of 46 kg/sec. Calculate (i) jet exit velocity, the enthalpy for the nozzle is 190 kJ/kg, (ii) flow rate of fuel, assuming air-fuel ratio is 82, (iii) thermal efficiency of the plant, (iv) propulsive power and thrust power, heating value of fuel is 44000 kJ/kg. Assume any data required.	15

********** The End **********

Department of Mechanical Engineering
Chittagong University of Engineering and Technology (C U E T)
Level 4, Term-II, Examination 2022

Course No: ME 411	Full Marks: 210	Time: 03 hours
Course Title: Applied Thermodynamics	Date: 12/ 02 / 2024	

The figures in the right margin indicate full marks. The questions are of equal value. There are 04 questions in each section. Answer any 03 questions from each section. Use separate script for each section.

Marks

Section: A

1 a) Differentiate between indicated power and brake power. 08

b) How constant volume combustion and constant pressure combustion are differed from each other? Where do these combustion happen? 10

c) A four-stroke four-cylinder automotive engine develops 150 Nm brake torque at 3000 rpm. Assuming brake mean effective pressure to be 0.925 bar and mean piston speed to be 12 m/s. Find (i) brake power, (ii) displacement volume, (iii) stroke and (iv) bore. 17

2 a) What is the difference between scavenging and supercharging? 10

b) Why actual cycle is different from fuel-air cycle? 10

c) Calculate the higher heating value of CH_4. Assume the fuel is fully vaporized and bomb calorimeter is used. Standard enthalpies of formation of $CH_4(g)$, $CO_2(g)$, $H_2O(g)$ and $H_2O(l)$ are -74.87 MJ/kmol, -393.52 MJ/kmol, -241.83 MJ/kmol and -285.84 MJ/kmol respectively. Datum temperature = 25°C, $\bar{R}$ = 8314.3 J/kmol.K. 15

3 a) Differentiate between SIE and CIE knocking mechanism. 13

b) How spark timing affects knock in SIE? 11

c) What is swirl? When is it necessary? 11

4 a) What is propulsion? Differentiate between turbo propeller and turbo fan systems. Mention uses. 12

b) Differentiate between ramjet and rocket propulsion systems. 09

c) A turbojet engine flying at a speed of 790 km/hr consumes air at the rate of 45 kg/sec. Calculate (i) jet exit velocity, the enthalpy change for the nozzle is 185 kJ/kg, (ii) flow rate of fuel, assuming air-fuel ratio is 78, (iii) thermal efficiency of the plant, given heating value of fuel is 44000 kJ/kg, and (iv) propulsive power. 14

Section: B

5 a) Why idling of SIE requires a rich mixture? 10

b) Why higher compression ratio is possible with gasoline direct injection system? 10

c) A two-stroke diesel engine of 13 cm bore, 15 cm stroke, compression ratio is 15 is running at 1800 rpm when the following measurements are made: 15
Fuel flow = 7.3 kg/hr, inlet air temperature = 21°C, exhaust pressure = 103 kPa, trapped air-fuel ratio = 0.04. Compute the scavenging efficiency.

6 a) Why cooling of IC engine is important? 08

b) How unburn hydrocarbon emissions are occurred in SIE? 10

c) A diesel engine operating on the 4-stroke cycle is to be designed to operate with the following characteristics where the mean conditions are: 1 bar and 25°C; brake power 254 kW; volumetric efficiency = 0.77; brake specific fuel consumption = 0.26 kg/(kW.hr); air-fuel ratio = 17:1; speed =1500 rpm. Calculate the required engine capacity and brake mean effective pressure. Heat of combustion of diesel fuel= 43,000 kJ/kg, Ra = 287 J/kg.K. 17

7 a) Derive a relation between compressor and turbine outlet temperature for getting maximum specific power consumption. 10

b) Explain with the help of schematic and *T-s* diagrams the compressor intercooling method of increasing gas turbine efficiency. 10

c) In a gas turbine plant, maximum and minimum temperature are 830°C and 30°C respectively. The pressure ratio is 4.2. Calculate the specific power output and cycle efficiency. Assume isentropic efficiency of the compressor and the turbine are 90 and 92 percent respectively. Given, C_p = 1.005 kJ/kg-K.

8 a) What is photovoltaic device? Explain p-type silicon and n-type silicon and working principle of photovoltaic device.. 18

b) What is fuel cell? Explain the working principle of H_2-O_2 fuel cell. 17

********** The End **********

Department of Mechanical Engineering
Chittagong University of Engineering and Technology (C U E T)
Level 4, Term II Examination 2021

Course No: ME 411	Full Marks: 210	Time: 03 hours
Course Title: Applied Thermodynamics	Date: **20 / 02 / 2023**	

The figures in the right margin indicate full marks. The questions are of equal value. There are 04 questions in each section. Answer any 03 questions from each section. Use separate script for each section.

Marks

Section: A

1. a) What are the purposes of testing of IC engine? Define indicated horse power, indicated mean effective pressure, brake horse power, specific fuel consumption and A/F ratio. 18
   b) An engine develops a brake power of 3.7 kW. It's indicated thermal efficiency is 30%, mechanical efficiency is 80%, heating value of the fuel is 42,000 kJ/kg and its specific gravity = 0.88. Calculate (i) the fuel consumption rate, (ii) indicated specific fuel consumption, (iii) brake specific fuel consumption. 17

2. a) Why actual cycle is different from fuel-air cycle? 8
   b) What is combustion efficiency? How equivalence fuel-air ration affects diesel engine combustion efficiency? 10
   c) Calculate the lower heating value of CH_4. Assume the fuel is fully vaporized and CH_4 is burned in a constant pressure process. Consider standard enthalpies of formation (at 25°C) of $CH_4(g)$, $CO_2(g)$, $H_2O(g)$, $H_2O(l)$ are –74.87 MJ/kmol, –393.52 MJ/kmol, –241.83 MJ/kmol, –285.84 MJ/kmol respectively. 17

3. a) How SIE knocking mechanism differ from CIE knocking mechanism? 13
   b) How supercharging affects knock in SIE and CIE? 10
   c) What are swirl and squish? How these play important role in CIE combustion? 12

4. a) What are the functions of electrodes and electrolytes in fuel-cell? Explain the working principle of H_2-O_2 fuel cell. 18
   b) What are n-type and p-type semiconductor? Explain how photovoltaic device produce electricity? 17

Section: B

5. a) Why idling of SIE requires rich mixture? 8
   b) Differentiate between part fuel injection and gasoline direct injection. Which process is more advantageous? 11
   c) A four stroke gasoline engine has a volumetric efficiency of 0.84. It has 12 cylinders, 150 mm bore, 200 mm stroke, and runs at 1500 rpm with indicated thermal efficiency of 0.30. The overall fuel-air ratio is 0.08 and density of air in the manifold is 0.82 kg/m^3. Compute the indicated mean effective pressure and indicated power. Heat of combustion = 42000 kJ/kg. 16

6. a) What is scavenging? Explain the scavenging process with cylinder pressure vs. crank angle diagram. 10
   b) Why larger engine is more efficient? 7
   c) How mechanical supercharging process is different from turbocharging? 8
   d) Why is diesel engine NO_2/NO_x decreases with the increase of load? 10

7. a) Define pressure ratio is gas turbine. Find the optimum pressure for gas turbine. 14
   b) Can Brayton cycle be modified? Why is it necessary? 6
   c) In a gas turbine plant, maximum and minimum temperatures are 830°C and 30°C respectively. The pressure ratio is 4.2. Calculate the specific crank output and cycle efficiency. Assume isentropic efficiency of the compressor and the turbine are 90 and 92 percent respectively. Given, C_p = 1.005 kJ/kg-K. 15

Please Turn Over

8. a) What do you mean by propulsion of jet? Describe the different devices for propulsion. 15

b) How is compression done in ramjet? Explain in brief. 6

c) A turbojet engine flying at a speed of 830 km/hr consumes air at the rate of 42 kg/s. Calculate : 14

(i) Jet exit velocity; the enthalpy changes for nozzle is 190 kJ/kg and the velocity coefficient is 0.92.

(ii) Flow rate of fuel considering air-fuel ratio is 85.

(iii) Propulsion power.

**********END OF QUESTION**********

Department of Mechanical Engineering

Chittagong University of Engineering and Technology (C U E T)

Level 4, Term II Examination 2020

Course No: ME 411	Full Marks: 210	Time: 03 hours
Course Title: Applied Thermodynamics	Date: 27 / 03 / 2022	

The figures in the right margin indicate full marks. The questions are of equal value. There are 04 questions in each section. Answer any 03 questions from each section. Use separate script for each section.

Marks

Section: A

1. a) How IC engine performance measured? Name five parameters to measure the performance. How significant these parameters are to measure the performance of an IC engine? 15

   b) The following readings are recorded from a single cylinder diesel engine working on 4-stroke cycle: 20

   The suction conditions are 1 bar and 50°C

   Brake power developed = 260 kW, rpm = 1500

   Volumetric efficiency = 80%, Air-fuel ratio = 18

   Specific fuel consumption = 0.25 kg/kW-h on brake power basis.

   Determine the dimensions of the engine cylinders taking stroke to bore ratio 1.25.

2. a) Why fuel-air cycle is different from actual cycle? 10

   b) How does equivalence fuel/air ratio affect engine combustion efficiency? 10

   c) Calculate the HHV of CH_4 considering the fuel is fully vaporized and bomb calorimeter is used. Standard formation of enthalpies for CH_4, CO_2, $H_2O(g)$ and $H_2O(l)$ are –74.85, –393.5, 241.82 and 285.85 MJ/kmol respectively. R = 8.3143 kJ/kmol-K. 15

3. a) Why higher compression ratio is not encouraged in SI engine? 9

   b) How spark plug location affects knock in spark ignition engine? 9

   c) Why does CI engine run at lower speed? 8

   d) How fuel/air ratio affects knock in spark ignition engine? 9

4. a) Why gasoline direct injection (GDI) system produces less knock and gives better volumetric efficiency? 10

   b) What is meant by fuel metering in CI engine? Differentiate between individual pump system and common rail system. 15

   c) Why the volumetric efficiency of IC engine decreases if the load is increased maintaining the speed constant? 10

Section: B

5. a) What is scavenging? How perfect mixing is different from complete short circuiting? When complete short circuiting could happen during the scavenging process? 11

   b) How CO forms in SI engine combustion? According to Bangladesh vehicular emission standards what is standard value of CO emissions from petro/octane vehicles. 8

   c) Estimate heat loss of 12 cylinders gasoline engine operating at 600 kW, fuel-air ratio = 0.08, inlet air temperature = 27°C, coolant temperature = 50°C, gas temperature = 400°C. The engine is of 146 mm bore and 146 mm stroke. Brake thermal efficiency = 0.23. Compute heat loss per unit piston area, ratio of heat loss to power, and ratio of heat loss to heat of combustion. Heat of combustion of gasoline fuel = 42 MJ/kg, $\mu_g = 32.5\times10^{-6}$ kg/m-sec, $k_g = 51.96\times10^{-6}$ kW/m-K. 16

6. a) Explain briefly the difference between direct and indirect cycle for gas turbines. Derive a relation between compressor and turbine outlet temperature for getting maximum specific power consumption. 18

   b) A gas turbine inlet receives air at 1 bar and 300K and compresses it adiabatically to 6.0 bar. The compressor efficiency is 90% where the fuel has heating value of 44,000 kJ/kg and fuel-air ratio is 0.017. The turbine efficiency is 92%. Calculate the work of the turbine and compressor per kg of air compressed and also find the thermal efficiency. For air c_p = 1.005 kJ/kg-K, γ = 1.4. For products of combustion c_p = 1.47 kJ/kg-K, γ = 1.33. 17

7. a) How turbofan engine are aerodynamically more efficient than turbo propeller engines? How energy produced from turbines are distributed in these engines? 12

   b) Differentiate between ramjet and rocket. Enlist the advantages of ramjet. 8

   c) An engine with turbojet is flying at a speed of 920 km/hr. It consumes air with a rate of 45 kg/s. Calculate (i) the exit velocity for enthalpy changes in the nozzle 180 kJ/kg, (ii) the flow rate of fuel when A/F ratio is 80, (iii) thermal efficiency for fuel with heating value of 45 MJ/kg. 15

8. a) How fuel cell is different from a battery? Explain the reactions occurred on anode and cathode of methane-oxygen fuel cell. 13

   b) Name some anode and cathode materials used in thermionic generator. What is saturation current density? 7

   c) Explain the working principle of magneto-hydrodynamic plant with neat sketches. 15

**********END OF QUESTION**********

Department of Mechanical Engineering
Chittagong University of Engineering & Technology (CUET)
Level 4, TermII Examination 2018

Course No:ME 411	Full Marks: 210	Time: 03 hours
Course Title:Applied Thermodynamics	Date: 11/07/2019	

The figures in the right margin indicate full marks. The questions are of equal value. There are 04 questions in each section. Answer any 03 questions from each section. Use separate script for each section.

Marks

Section: A

1. a) What is internal combustion engine? Compare SI and CI engine with respect to i) compression ratio ii) ignition iii) Speed — 15
   b) In a performance test on a four-stroke engine, the indicator diagram area was found to be 5×10^{-4} m^2 and the length of the indicator diagram was 0.05m. If the y-axis has a scale of 1 m=50 MPa, find the indicated mean effective pressure of the engine given that bore=150mm, stroke=200mm. The measured engine speed was 1200 rpm. Also calculate the indicated power and indicated specific fuel consumption of the engine if the fuel injected per cycle is 0.5 cc with the specific gravity 0.8. — 20

2. a) Explain intake process of internal combustion engine for unthrottled operation ($P_i=P_e$), throttled operation ($P_i<P_e$) and supercharged operation ($P_i>P_e$) — 15
   b) Calculate the lower heating value of CH_4 (gas) when it is burned in a bomb calorimeter with air. The standard enthalpies of formation of CH_4(g), CO_2(g), H_2O (g) and H_2O (*l*) are -74.87 MJ/Kmol, -393.52 MJ/Kmol, -241.83 MJ/Kmol and -285.84 MJ/Kmol respectively. $\bar{R}$ =8314.3 J/Kmol.K, T_0 =298.15 K — 20

3. a) If spark 28^0 BTC gives slight knock, then spark 32^0 BTC gives intense knock, Explain why? — 12
   b) Explain why the increase of the time of exposure of the unburned mixture to autoigniting conditions will increase the possibility of knock in SIE? — 12
   c) Explain the combustion process in the compression ignition engine. — 11

4. a) Why idling of SIE requires a rich mixture? — 10
   b) What is nozzle? What are the functions of a nozzle in CIE? — 08
   c) A four stroke gasoline engine has a volumetric efficiency of 0.83. It has 12 cylinders, 150 mm bore, 200 mm stroke and runs at 1500 rpm with indicated thermal efficiency of 0.31. The overall fuel-air ratio is 0.08 and density of air in the manifold is 0.81 kg/m^3. Compute the indicated mean effective pressure and indicated power. Heat of combustion is 42000 kJ/kg. — 17

Section: B

5. a) What is supercharging? How is it achieved? — 13
   b) How can constituents of exhaust gases be controlled? Describe briefly. — 13
   c) Why does CI engine exhaust gases contain insignificant amount of CO? — 09

6. a) Show that the specific power of a single gas turbine cycle is maximum when the pressure ratio is such that the compressor and turbine outlet temperatures are equal. — 17
   b) In a gas turbine plant, maximum and minimum temperatures are 825^{0}C and 25^{0}C respectively. The pressure ration is 4.5. Calculate the specific work output, and cycle efficiency. Assume isentropic efficiencies of the compressor and the turbine are 85% and 90% respectively. Given C_p=1.005 kJ/KgK. — 18

7. a) What is photovoltaic device? What are p-type and n-type semiconductors? Explain the working principle of photovoltaic device. What is gap energy? — 18
   b) What is thermionic device? Explain working principle of thermionic device? What is saturation current density? — 17

8. a) What is meant by propulsion? Differentiate between ramjet and rocket propulsion system. — 17
   b) A turbojet engine flying at a speed of 800 Km/hr consumes air at the rate of 45 kg/s. Calculate: i) jet exit velocity if the enthalpy change for the nozzle is 168 kJ/kg. ii) flow rate of fuel, assuming air-fuel ratio is 80 iii) the thermal efficiency of the plant, given calorific value of fuel used is 41750 kJ/Kg iv) Propulsion power v) Propulsive efficiency — 18

**********THE END**********