Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	AIRCRAFT SYSTEMS
COURSE CODE	:	BDX 21003
PROGRAMME CODE	:	BDX
EXAMINATION DATE	:	JULY / AUG 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. PART A : ANSWER **ALL** QUESTIONS. 2. PART B : ANSWER **ONE (1)** FROM **TWO (2)** QUESTIONS. 3. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK.** 4. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **SEVEN** (7) PAGES

PART A

Q1 (a) Flaps are important components of an aircraft's wing that are used to modify its aerodynamic properties during takeoff and landing. Describe the function of the flap and differentiate the **THREE (3)** type of flaps.

(8 marks)

(b) The structures of the helicopter are designed to give the helicopter its unique flight characteristics. Explain and sketch the mechanism of the pitch in helicopter movement

(4 marks)

(c) Differentiate and sketch the aircraft roll and yaw motion mechanism in terms of part's control and pilot's control

(8 marks)

Q2 (a) In the aviation industry, monitoring and inspecting the structure of aircraft is essential to ensure that is it airworthy. Suggest four non-destructive testing (NDT) methods that can be used for periodic inspections.

(4 marks)

(b) The heating system is an essential component of aircraft environmental control systems that ensures the cabin's comfortable and safe conditions for passengers and crew members. The heating system is responsible for maintaining the temperature inside the cabin, preventing the formation of ice on critical components such as the wings, engine inlets, and windshields. Compare the operation of a combustion heater and a radiant panel in an aircraft's heating system.

(6 marks)

(c) Take off and landing are two critical operations in aviation, and understanding their differences and performance factors is essential to ensure safe and efficient flight. Differentiate the takeoff and landing operation in terms of the meaning and performance factor. Use figure to explain the operation mechanism

(10 marks)

Q3 (a) In an aircraft's air conditioning system, the main compressor delivers the air at 5 bar and 200°C. The bled air taken from the compressor is passed through a heat exchanger so that the temperature of the air leaving the heat exchanger is 45°C and the pressure is 4.5 bar. The air leaving the heat exchanger passes through the cooling turbine and then supplied to the cabin at 1 bar. The pressure loss between the cooling turbine and cabin is 0.2 bar. If the rate of flow of air through the cooling turbine is 20 kg/min, determine the following:

(i) The actual temperature of the air leaving the cooling turbine.

(4 marks)

(ii) The power delivered to the ram air, which is passed through the cooling turbine.

(2 marks)

Assume that the isentropic efficiency of the cooling turbine is 75% and no loss of heat from the air between the cooling turbine and cabin. Take $\gamma = 1.4$ and $C_p = 1$ kJ/kgK. Refer to the T-S diagram in **Figure Q3(a)**.

(b) A fighter jet's engine requires lubrication to ensure its efficient performance. The oil enters the engine at a temperature of 25°C and exits at 70°C. The mass of the oil is 0.4 kg and has a specific heat capacity of 2200 J/(kg°C). Calculate the amount of heat energy absorbed by the oil.

(3 marks)

(c) An aircraft is flying at an altitude where the outside temperature is -20°C. The aircraft's engine generates heat, which is absorbed by an aluminum alloy component with a mass of 2 kg. If the temperature of the component rises from -20°C to 120°C, calculate the heat absorbed by the component. Assume that the specific heat capacity of the aluminum alloy component at constant pressure is 0.92 kJ/(kg°C).

(3 marks)

(d) Describe the P-V diagram of the Ideal Otto cycle employed in an aircraft piston engine

(8 marks)

Q4 (a) A Boeing 747-400 is descending from an altitude of 35,000 ft to 5,000 ft at a rate of 800 fpm. At the altitude of 35,000 ft, the cabin is pressurizing at level 8,000 ft. The pilot wants the cabin pressure to be at 2,000 ft when the aircraft reaches 5,000 ft. Calculate the ideal rate of descent for the cabin pressure.

(8 marks)

(b) A pressurisation system ensures the comfort and safety of crew and passengers when flying at high altitude. This is done by controlling the cabin pressure and the exchange of air from the inside of the aircraft to the outside. Explain **TWO (2)** benefit obtain by an aircraft when flying at a high altitude.

(4 marks)

(c) Sketch and describe the difference between engine-driven vacuum pump system operation and venture tube system operation of an aircraft.

(8 marks)

Part B

Q5 (a) Nickel-Cadmium (NiCad) batteries are widely used in aircraft electrical systems due to their reliability, low self-discharge rate, and high energy density. Evaluate the disadvantages of using Nickel-Cadmium batteries in aircraft electrical systems and recommend strategies to mitigate their disadvantages.

(7 marks)

(b) Discuss various alternatives to hydraulic shock absorber used in the landing gear of most large aircraft.

(4 marks)

(c) A SASI hydraulic system hand pump is shown in **Figure Q5(c)**. Suppose that the force delivered is F_1 = 100 lb at a distance D_1 = 20 inches from the pump handle pivot, and that D_2 = 1 inch is the distance between the pivot and the pump piston. If the piston area on which the oil acts is A = 2 in^2, obtain the maximum pressure developed.

(9 marks)

Q6 (a) A battery is a device that converts electrical energy from the alternator into chemical energy. There are two kinds of batteries used in aircraft electrical system: Lead-acid and Nickel-Cadmium. Compare and contrast the advantages and disadvantages of lead-acid and nickel-cadmium batteries used in aircraft electrical systems.

(6 marks)

(b) The 123,456 kg airplane in **Figure Q6(b)** is at rest on the ground. The landing gear carriages are at A, B and C. The coordinates of the point G at which the weight of the plane are (3, 0.5, 5) m. Calculate the magnitudes of the normal reactions exerted on the landing gear by the ground?

(9 marks)

(c) Sketch an aircraft hydraulic system and discuss the main function of two main components in a hydraulic system.

(5 marks)

- END OF QUESTION –

FINAL EXAMINATION

SEMESTER/SESSION	: SEM II/2022/2023	PROGRAMME CODE	: BDX
COURSE NAME	: AIRCRAFT SYSTEMS	COURSE CODE	: BDX 21003

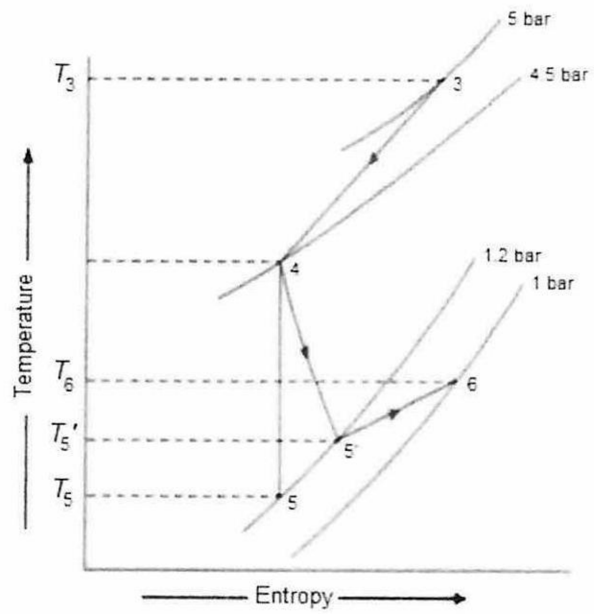

Figure Q3(a)

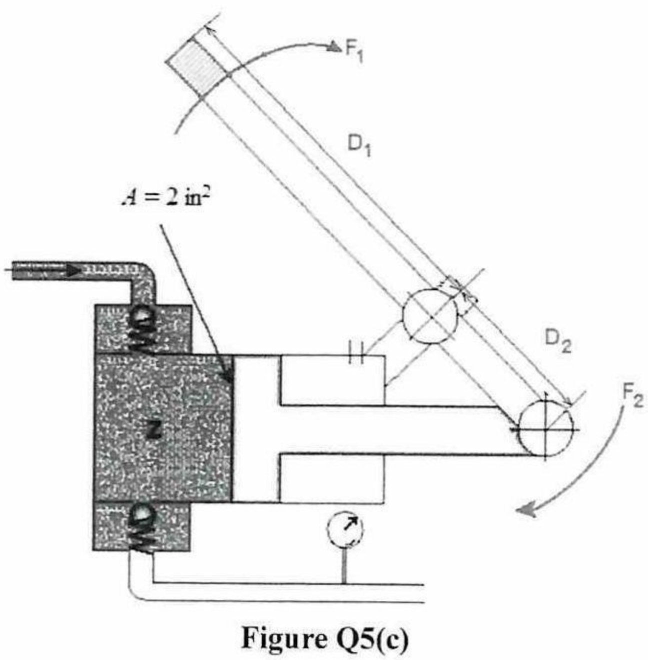

Figure Q5(c)

FINAL EXAMINATION

SEMESTER/SESSION	: SEM II/2022/2023	PROGRAMME CODE	: BDX
COURSE NAME	: AIRCRAFT SYSTEMS	COURSE CODE	: BDX 21003

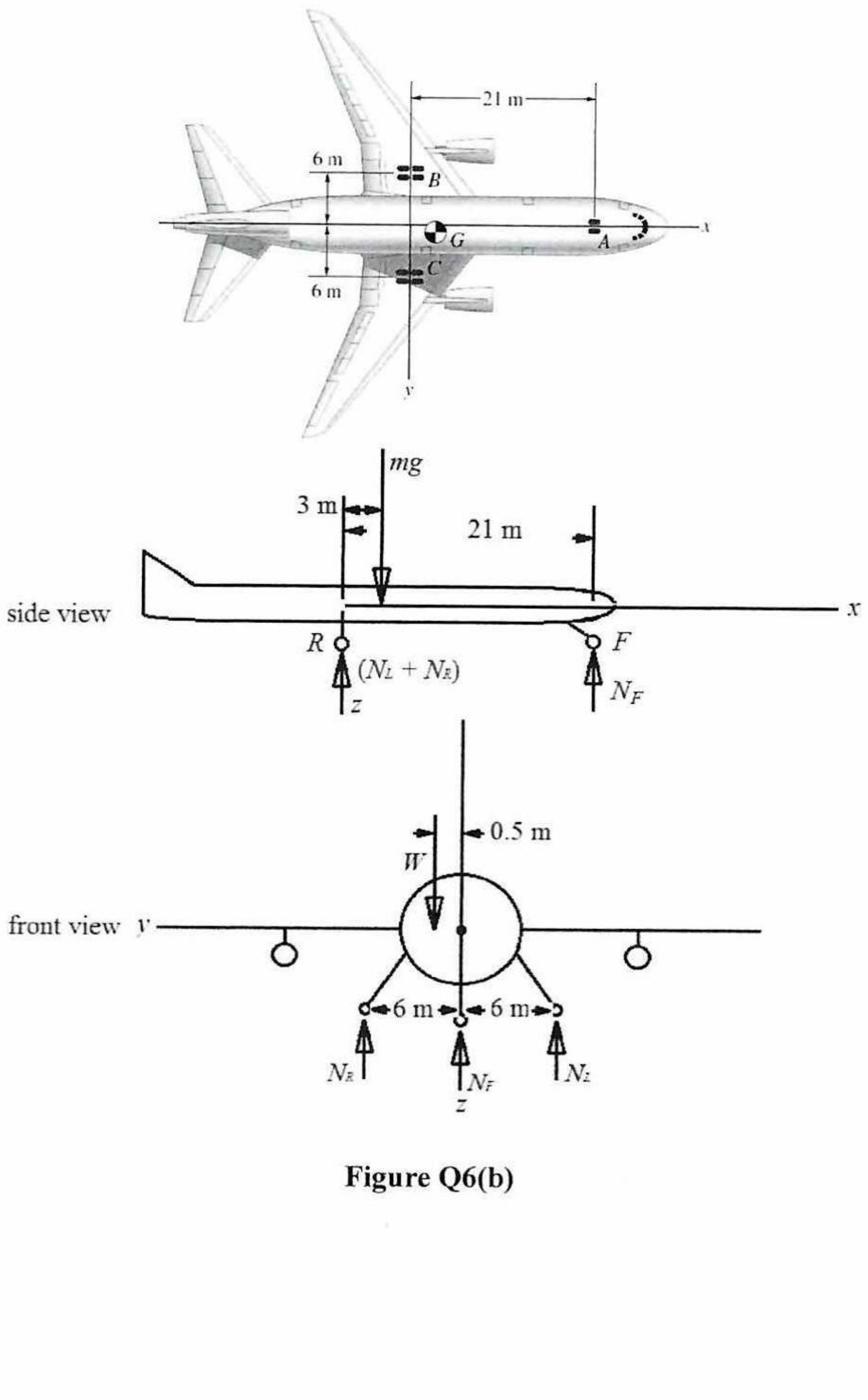

Figure Q6(b)