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KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

COLLEGE OF ENGINEERING

B.Sc. (Engineering) Second Semester Examination, April 2011
Third Year
AERO 368 Air Vehicle Performance
Time: 2 hours 30 minutes

ATTEMPT ALL QUESTIONS IN SECTION A AND ANY TWO QUESTIONS FROM SECTION B

SECTION A

Q. 1

A Piper reconnaissance airplane flies from Niamey, through Gao, Ouagadougou, Tamale, Pampa, and Niamtougou and then back to Niamey. The distances between the respective airports are given in Table 1. Assume that the pressure altitude and temperature at Niamey and Gao airports are 3000 ft and 70 °F respectfully; while those at all the other airports are 4000 ft and 80 °F. However, conditions at the cruise altitude are the same. The pressure altitude and temperature at the cruise altitude are 6000 ft and 60 °F, respectively. Refueling the airplane takes 30 minutes. The fuel tank of the airplane has a maximum capacity of 55 gallons and for safety, there should be a fuel reserve of 9 gallons. Using the PA-28-181 charts provided, answer the following questions. Show all calculations done in your answer booklet clearly.

Table 1

Airport	Distance (nmi.)	Time (hr.)	Fuel Required (gal.)	Fuel used; Cummulative (gal.)	Time spent; Cummulative (hr.)
NY - GAO	215	1·055	13·2	14·2	1·925
GAO - OG	250	1·264	15·45	29·65	4·179
OG - TLE	170	1·5	11·83	41·48	5·679
TLE - PAM	130	1·45	10·45	51·93	7·129
PAM - NT	110	0·971	8·86	60·79	8·100
NT - PA	100	0·9	8·5	69·29	9·000
PA - NY	244	2·139	19·55	88·84	11·139

i. What is the airspeed of the airplane at the cruise altitude if it flies at 65 % power.
ii. Determine the time, distance and fuel to climb to the cruise altitude at Gao.
iii. Determine the time, distance and fuel to climb to the cruise altitude at Tamale.
iv. Copy and complete Table 1.

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v. How often do you have to refuel?
vi. Where would you refuel?
vii. How long will the whole trip take?

30 Marks

Q2.

The gross weight of a piper PA-28-181 is 2350 lb. It takes off from an airport with full throttle before brake release, on a paved, level and dry runway. If the altimeter reading at takeoff is 3500 ft and the altimeter setting is 28.8 inches Hg

i. Find the pressure altitude at the airport.
ii. Find the density altitude at the airport if the prevailing temperature at the airport is 10 °C.
iii. Find the ground roll at takeoff, if the wind at the airport is a 7.5 knots headwind.
iv. Find the airborne distance at takeoff, if the wind at the airport is a 7.5 knots headwind.
v. What is the total takeoff distance of the airplane?
vi. Comment on the performance of the airplane as a result of the 7.5 knots head wind.

20 marks

Q3.

Table 2 gives the information of a loaded airplane.

Table 2

Item	Weight	Arm	Moment
Empty Weight	1400	81	
Front Seat	370	68	
Rear Seat	510	106	
Cargo	40	134	
Fuel	170	80	
Oil	11	-25	

i. Find the center of gravity of the loaded airplane if the arms given are distances aft of the datum of the airplane.

ii. Plot the center of gravity in the flight safe envelope provided.

iii. Is the airplane safe to takeoff? Give reasons.

iv. The airplane was redesigned such that only the datum was changed. If the datum was moved 5 inches closer to the oil (i.e. closer to the nose), by redrawing Table 1, fill in the

respective new information and calculate the new center of gravity of the loaded airplane, if the same weights were used.

v. Plot the center of gravity of the newly designed airplane in the flight safe envelope provided.

vi. Is this newly designed airplane safe to takeoff? Give reasons.

vii. Compare your results in (i) and (iv) and comment on the results.

10 marks

SECTION B

Q4.

An airplane with a gross mass of 1030.5 kg. carries fuel of 400.5 kg flying at a speed of 243.5 m/s. If the maximum value of the lift to drag ratio is 14.40 and the specific fuel consumption is 1.916×10^{-4}/s:

i. Calculate the maximum endurance for a jet propelled airplane in hours.
ii. Calculate the maximum range of the airplane in kilometers.

b.

i. A military airplane is flying at an altitude of 30,400 ft at a velocity of 780 ft/s. What is its energy height?

ii. If a similar aircraft flies at an altitude of 100,400 ft at the same speed, what is its energy height?

iii. Compare your answers in (i) and (ii),and specifically comment on their combat performance.

20 marks

Q5

A jet propelled commercial airplane has a wing platform area of 4500 ft^2, takeoff weight of 420,000 lb and liftoff velocity of 233 ft/s. By ignoring ground effect:

a. Calculate the lift coefficient at liftoff for standard sea level conditions.
b. Calculate the lift coefficient at liftoff for standard sea conditions at an airport which is 5000 ft above sea level.

c. If the lift to drag ratio of the aircraft is 15.0, what is the drag at liftoff at sea level conditions.

d. Compare your answers in (a) and (b), and comment on your results.

20 marks

Q6.

For the NACA 2412 airfoil given in Figure 3, calculate the lift-to-drag ratios at angles of attack (α) of:

a. 0°,
b. 6°
c. 9°
d. 13°

Assuming a Reynold's number of 8.9×10^6 is applicable.

e. Compare your answers in (a), (b), (c) and (d). Comment on your results.

20 marks