Hall Ticket No | | | | | | | | | | | Question Paper Code: AAEB09

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER-I

B.Tech IV Semester End Examinations, MAY/JUNE – 2020

Regulations: IARE - R18

FLIGHT MECHANICS

(Aeronautical Engineering)

Time: 3 hours **Max. Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1.	a)	Write about drag reduction methods. Name all methods and explain one method with required diagram.	**[7M]**
	b)	Plot the international atmosphere with elevation and temperature. Explain salient features of this plot.	**[7M]**
2.	a)	Write the relation between sea level gravity and gravity at flying. How these terms are related? Write the expression and explain.	**[7M]**
	b)	Derive expression for maximum lift to drag ratio (L/D). With respect to the coefficient of drag ($C_{D,0}$) at zero angle of attack.	**[7M]**

UNIT – II

3.	a)	Derive the range expression for a jet powered aircraft. Explain each term in detail	**[7M]**
	b)	"The maximum range, in the presence of wind, is not obtained at Em but at a different L/D". Discuss this issue and give your opinion on this statement with necessary formula and plot.	**[7M]**
4.	a)	What are the Equations of Motion in straight and level flight? Derive the Equations of Motion in straight and level flight and explain each term.	**[7M]**
	b)	For a commercial aircraft with total weight is 30000 kg, S= 90 m^2, $C_{D,0}$=0.012, K=0.09. If the velocity of the airplane is 140 m/s. Calculate the minimum power required and the velocity at which this occurs. (Take standard conditions at sea level).	**[7M]**

UNIT – III

5.	a)	Derive the expression for the Maximum Climb Angle by using analytical approach for jet propelled airplane	**[7M]**
	b)	Given an airplane mass of 50000 kg, Lift/Drag ratio 10, thrust per engine 60, 000N, assume g=10 m/s^2. For a straight, steady, wings level climb of a twin engine airplane. Calculate the all engine climb gradient	**[7M]**

6. a) Draw the diagram of shallow and deep climb angles and write the equations of motion in both nconditions.What is the correct relationship between the true airspeed for (i) minimum sink rate (ii) minimum glide angle at a given altitude. **[7M]**

b) Determine the range of the following propeller-driven aircraft, with the following data, at a constant airspeed of 80.5 m/s at 2440 m altitude: W_1 =82.29 kN, W_{fuel} = 26.69 kN, S = 87 m^2, η p = 0.85, C = 2.0 N/HP-hr, C= 0.0192 +0.047$C_{L.}^2$. **[7M]**

UNIT – IV

7. a) What are the limitations of the structural boundaries of the airplane? Explain with sketch. **[7M]**

b) Derive the expression for turning velocity during maneuvering flight of an airplane. **[7M]**

8. a) Draw the turn maneuverability energy diagram for an aircraft and explain its salient features. How these features are significant for determination of the performance of an aircraft? **[7M]**

b) Calculate the minimum turn radius, load factor , velocity and Coefficient of lift at sea level for Airbus 310: Details are given: K=0.08, W/S=76.84, T/W= 0.37, $C_{D,0}$= 0.015(missing data can be assumed). **[7M]**

UNIT – V

9. a) Describe the pull-up maneuvers with neat sketches and also explain the importance of V-n diagram **[7M]**

b) An airplane with a wing area of 20 m^2 and a weight of 19,620 N dives with engine switched off, along a straight line inclined at 60^o to the horizontal. What is the acceleration of the airplane when the flight speed is 250 kmph? If the airplane has to pull out of this dive at a radius of 200 m, what will be the lift coefficient required and the load factor? Drag polar is given by: $C_D = 0.035 + 0.076C^2$ and the maneuver takes place around an altitude of 2 km. **[7M]**

10. a) Draw the V-n diagram and explain its important point. How this diagram is significant for pilot operating the plane?. **[7M]**

b) Derive the ground run distance for landing performance. What is the importance of ground run? Why it is needed? **[7M]**

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COURSE OBJECTIVES:

The course should enable the students to:	
I	Learn the different regimes of aircraft and performance requirements at different atmospheric conditions.
II	Understand the different type of velocities and gives differences between stall velocity and maximum and minimum velocities.
III	Estimate the time to climb and descent and relate between rate of climb and descent and time to climb and descent at different altitudes.
IV	Illustrate the velocity and radius required for different type of maneuvers like pull-up, pull down and steady turn.
V	Evaluate the equations of motion for an airplane in different flight modes like takeoff, cruise and landing.

COURSE OUTCOMES (COs):

CO 1	Understand the design mission, performance, standard atmosphere, aerodynamic and propulsive forces, different speeds and estimation methods of aircraft.
CO 2	Remember and describe the cruise performance of an airplane in relation with range and endurance with different types of engines also to understand effects of weight, altitude and temperature on performance.
CO 3	Determine and apply the concept of climb and descent performance and to calculate power for best climb and descent performance.
CO 4	Describe about aircraft maneuver performance in turn, pull-ups by considering limitations of power for military and civil aircrafts.
CO 5	Explore the methods to calculate take off and landing runway distances and to understand fuel planning, safety and environment effects of aircraft performance.

COURSE LEARNING OUTCOMES (CLOs):

CLO Code	**At the end of the course, the student will have the ability to:**
AAEB09.01	Remember the atmospheric conditions that are suitable for better performance of an aircraft.
AAEB09.02	Understand the basics of mathematics, science and engineering for problem solving.
AAEB09.03	Describe different atmospheric models that an aircraft encounters in its real-time flight.
AAEB09.04	Apply and demonstrate different methods for the measurement of air data and their respective systems working principle.
AAEB09.05	Remember mission profiles that an aircraft adapts depending upon its category and requirements.
AAEB09.06	Understand different phases of design process from performance standpoint.
AAEB09.07	Describe definition of aircraft performance for different categories of aircraft.
AAEB09.08	Apply and demonstrate the force system of the aircraft and the development of equations of motion.
AAEB09.09	Understand the performance of aircraft in cruising phase and appropriate conclusions are drawn.
AAEB09.10	Illustrate the climb and descent performance of the aircraft and its performance parameters are measured.

AAEB09.11	Evaluate the concept behind various methods that are employed during takeoff and landing phases depending upon its mission.
AAEB09.12	Apply the factors that enhance the performance of aircraft during takeoff and landing.
AAEB09.013	Understand the maneuver performance of typical transport and military aircrafts.
AAEB09.14	Evaluate the parametric performance data analysis for different phases of aircraft and various methods of measurement.
AAEB09.15	Illustrate the concept of flight planning, fuel planning and how it affects the performance of aircraft.
AAEB09.16	Apply the propulsive force characteristics like thrust that affects the aircraft performance.
AAEB09.17	Understand the flight measurement of performance, with detailed sections on airworthiness certification and the performance manual.
AAEB09.18	Illustrate the calibration methods that are used for the aircraft instruments to derive air data.
AAEB09.19	Evaluate the aerodynamic force characteristics like lift and drag that affects the aircraft performance.
AAEB09.20	Apply the full equation of motion, which are developed and used in the expressions for maneuver performance.

MAPPING OF SEMESTER END EXAMINATION TO COURSE OUTCOMES

SEE Question No		Marks Allotted	CLO Code	Course Learning Outcomes	Course outcomes	Blooms Taxonomy Level
1	a	7	AAEB09.01	Apply Remember and understand the atmospheric conditions that are suitable for better performance of an aircraft.	CO1	Remember
	b	7	AAEB09.01	Adapt the basic Remember of mathematics, science and engineering for problem solving.	CO1	Understand
2	a	7	AAEB09.04	Demonstrate different methods for the measurement of air data and their respective systems working principle.	CO1	Remember
	b	7	AAEB09.03	Describe different atmospheric models that an aircraft encounters in its real-time practice.	CO2	Understand
3	a	7	AAEB09.05	Describe mission profiles that an aircraft adapts depending upon its category and requirements.	CO2	Remember
	b	7	AAEB09.07	Identify definition of aircraft performance for different categories of aircraft.	CO2	Evaluate
4	a	7	AAEB09.06	Understand different phases of design process from performance standpoint.	CO2	Remember
	b	7	AAEB09.08	Explain the force system of the aircraft and the development of equations of motion	CO2	Understand
5	a	7	AAEB09.10	Illustrate the climb and descent performance of the aircraft and its performance parameters are measured.	CO3	Apply
	b	7	AAEB09.09	Evaluate the performance of aircraft in cruising phase and appropriate conclusions are drawn.	CO3	Apply
6	a	7	AAEB09.10	Illustrate the climb and descent performance of the aircraft and its performance parameters are measured.	CO3	Remember
	b	7	AAEB09.12	Evaluate the factors that enhance the performance of aircraft during takeoff and landing.	CO3	Apply
7	a	7	AAEB09.13	Understand the maneuver performance of typical transport and military aircrafts.	CO4	Remember
	b	7	AAEB09.14	Understand the parametric performance data analysis for different phases of aircraft and various methods of measurement.	CO4	Apply
8	a	7	AAEB09.16	Understand the propulsive force characteristics like thrust that affects the aircraft performance.	CO4	Remember

SEE Question No		Marks Allotted	CLO Code	Course Learning Outcomes	Course outcomes	Blooms Taxonomy Level
	b	7	AAEB09.17	Describes the flight measurement of performance, with detailed sections on airworthiness certification and the performance manual.	CO4	Apply
9	a	7	AAEB09.11	Understand the concept behind various methods that are employed during takeoff and landing phases depending upon its mission.	CO5	Remember
	b	7	AAEB09.19	Understand the aerodynamic force characteristics like lift and drag that affects the aircraft performance.	CO5	Understand
10	a	7	AAEB09.20	Evaluate the full equation of motion, which are developed and used in the expressions for maneuver performance.	CO5	Remember
	b	7	AAEB09.20	Evaluate the full equation of motion, which are developed and used in the expressions for maneuver performance.	CO5	Understand

Signature of Course Coordinator

Mrs.Madhurakavi Sravani , Assistant Professor **HOD, AE**