

CBCS SCHEME

USN

--	--	--	--	--	--	--	--	--	--

15AE82

Eighth Semester B.E. Degree Examination, Aug./Sept.2020 Flight Vehicle Design

Time: 3 hrs.

Max. Marks: 80

Note: i) For Regular Students: Answer any FIVE full questions irrespective of modules.

ii) For Arrear Students : Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- 1 a. Explain the phases of design of an aircraft with the help of a flow chart. (08 Marks)
b. Calculate near exact weight of an aircraft from a guess value for the following data, where W_e is the empty weight and W_o is the takeoff weight.

$$\frac{W_e}{W_o} = 0.93 W_o^{-0.07}; \quad W_o = \frac{10,800}{1 - 0.314 - \frac{W_e}{W_o}} \quad (08 \text{ Marks})$$

- 2 a. Define thrust to weight ratio. Give the expression for $\frac{T}{W}$ of propeller and jet airplanes. (06 Marks)
b. Derive an expression for wing loading effect on flight ceiling and glide rate. (10 Marks)

Module-2

- 3 a. Explain in detail the steps involved in conic fuselage development using conic lofting technique. (08 Marks)
b. Show that for a straight, tapered wing, mean aerodynamic chord (MAC) is $\bar{C} = \frac{2}{3} C_r \left(\frac{\lambda^2 + \lambda + 1}{\lambda + 1} \right)$, where λ is taper ratio and C_r is root chord. (08 Marks)
- 4 a. Give justification for the placement of tail stabilizers in a conventional tail for maximum stall and spin control. (08 Marks)
b. Write a typical spread sheet for vertical tail stabilizer sizing. (08 Marks)

Module-3

- 5 a. Explain the selection criteria of propulsion system of an aircraft. (08 Marks)
b. Explain installed thrust correction of an aircraft propulsion system. (08 Marks)
- 6 a. Obtain an expression for takeoff ground roll distance and list the minimum takeoff parameters required for commercial aircraft. (08 Marks)
b. Briefly explain about passive and active lift enhancement. (08 Marks)

Module-4

- 7 a. Discuss on lateral stability criterion on aircraft design. (08 Marks)
b. Obtain control surface sizing for longitudinal control. (08 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and/or equations written eg. 42+8 = 50, will be treated as malpractice.

USN

--	--	--	--	--	--	--	--	--	--

Eighth Semester B.E. Degree Examination, Jan./Feb. 2021
Flight Vehicle Design

Time: 3 hrs.

Max. Marks:100

Note: Answer any FIVE full questions, selecting at least TWO questions from each part.

PART - A

- 1 a. Explain the process of designing an aircraft with the help of a flow chart. (10 Marks)
 b. Calculate near exact weight of an airplane from a guess value for the following data, where W_e is the empty weight and W_o is the take-off weight:

$$\frac{W_e}{W_o} = 0.8835W_o^{-0.07} \text{ and } W_o = \frac{10800}{0.613 - \frac{W_e}{W_o}} \quad (10 \text{ Marks})$$

- 2 a. Define the term 'Wing Loading'. Briefly explain the consideration for selection of $\frac{W}{S}$ for an aircraft under design process. (10 Marks)
 b. Derive and explain :
 i) Wing loading effect on range
 ii) Effect of aspect ratio on aircraft performance. (10 Marks)

- 3 a. Show that for a straight tapered wing, mean aerodynamic chord (MAC) is $\bar{C} = \frac{2}{3}C_r \left(\frac{\lambda^2 + \lambda + 1}{\lambda + 1} \right)$, where λ is the taper ratio and C_r is root chord. (10 Marks)
 b. Write a typical spread sheet for main wing design. (10 Marks)

- 4 a. Show in a graph the variation of drag due to lift, zero-lift drag and total drag with velocity. Also show how power required and power available in piston - engine propeller aircraft varies with velocity. (10 Marks)
 b. Write a typical spread sheet for Turbojet engine sizing. (10 Marks)

PART - B

- 5 a. Write the equation of motion of landing roll and obtain an expression for landing ground roll distance. (10 Marks)
 b. Explain three common approaches used for active lift enhancement, with the help of neat sketches. (10 Marks)
- 6 a. Explain 'aft tail design' effects in longitudinal stability of an aircraft. (10 Marks)
 b. Explain contribution of fuselage wing and vertical stabilizer towards lateral stability. (10 Marks)
- 7 a. Sketch and explain three commonly used landing gear arrangements. (10 Marks)
 b. Explain anti-icing and de-icing systems in an aircraft. (10 Marks)
- 8 Write short notes on :
 a. Radio navigation systems (08 Marks)
 b. Primary and secondary flight control systems (06 Marks)
 c. Aircraft weapon systems. (06 Marks)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2017-2018

FLIGHT VEHICLE DESIGN
 [As per Choice Based Credit System (CBCS) scheme]
SEMESTER – VIII

Subject Code	17AE82	IA Marks	40
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	60

CREDITS – 04

Course Objectives: This course will enable students to

1. Comprehend the flight vehicle design process.
2. Acquire the knowledge of vehicle configuration and structural components.
3. Understand the stability & control and subsystems.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
<p>Module -1</p> <p>Overview of Design Process: Introduction, Requirements, Phases of design, Conceptual Design Process, Initial Sizing, Take-off weight build up, Empty weight estimation, Fuel fraction estimation, Take-off weight calculation.</p> <p>Thrust to Weight Ratio & Wing Loading: Thrust to Weight Definitions, Statistical Estimate of T/W. Thrust matching, Spread sheet in design, Wing Loading and its effect on Stall speed, Take-off Distance, Catapult take-off, and Landing Distance. Wing Loading for Cruise, Loiter, Endurance, Instantaneous Turn rate, Sustained Turn rate, Climb, & Glide, Maximum ceiling.</p>	6 Hours	L1, L2
<p>Module -2</p> <p>Configuration Layout & loft: Conic Lofting, Conic Fuselage Development, Conic Shape Parameter, Wing-Tail Layout & Loft. Aerofoil Linear Interpolation. Aerofoil Flat-wrap Interpolation. Wing aerofoil layout-flap wrap. Wetted area determination. Special considerations in Configuration Layout: Aerodynamic, Structural, Detectability. Crew station, Passenger, and Payload arrangements.</p> <p>Design of Structural Components: Fuselage, Wing, Horizontal & Vertical Tail. Spreadsheet for fuselage design. Tail arrangements, Horizontal & Vertical Tail Sizing. Tail Placement. Loads on Structure. V-n Diagram, Gust Envelope. Loads distribution, Shear and Bending Moment analysis.</p>	6 Hours	L1, L2

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2017-2018

<p>Module -3 Engine Selection & Flight Vehicle Performance Turbojet Engine Sizing, Installed Thrust Correction, Spread Sheet for Turbojet Engine Sizing. Propeller Propulsive System. Propeller design for cruise. Take-off, Landing & Enhanced Lift Devices :- Ground Roll, Rotation, Transition, Climb, Balanced Field Length, Landing Approach, Braking, Spread Sheet for Take-off and Landing. Enhanced lift design -Passive & Active. Spread Sheet</p>	8 Hours	L1, L2, L3
<p>Module -4 Static Stability & Control Longitudinal Static Stability, Pitch Trim Equation. Effect of Airframe components on Static Stability. Lateral stability. Contribution of Airframe components. Directional Static stability. Contribution of Airframe components. Aileron Sizing, Rudder Sizing. Spread Sheets. Flying qualities. Cooper Harper Scale. Environmental constraints, Aerodynamic requirements.</p>	10 Hours	L1, L2, L3
<p>Module -5 Design Aspects of Subsystems Flight Control system, Landing Gear and subsystem, Propulsion and Fuel System Integration, Air Pressurization and Air Conditioning System, Electrical & Avionic Systems, Structural loads, Safety constraints, Material selection criteria.</p>	10 Hours	L1, L2, L3
<p>Course Outcomes: After studying this course, students will be able to:</p> <ol style="list-style-type: none"> 1. Calculate the thrust to weight ratio and wing loading. 2. Compute the flight vehicle performance. 3. Select the subsystems as per vehicle design. 		
<p>Graduate Attributes:</p> <ul style="list-style-type: none"> o Engineering Knowledge. o Problem Analysis. o Design / development of solutions o Interpretation of data 		
<p>Question paper pattern:</p> <ul style="list-style-type: none"> • The question paper will have ten questions. • Each full question consists of 16 marks. • There will be 2 full questions (with a maximum of four sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. • The students will have to answer 5 full questions, selecting one full question from each module. 		

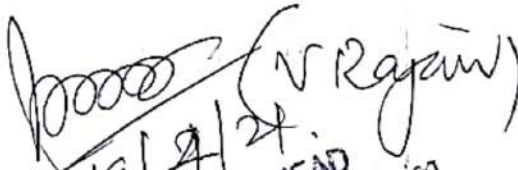
VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2017-2018

Text Books:

1. Daniel P. Raymer, Aircraft Design - A Conceptual Approach- AIAA Education Series, IV Edition, 2006.
2. Thomas C Corke, Design of Aircraft- Pearson Edition. Inc. © 2003.

Reference Books:

1. J Roskam, Aeroplane Design -Vol: 1 to 9
2. John Fielding, Introduction to Aircraft Design - Cambridge University Press, 2009
3. Standard Handbook for Aeronautical & Astronautical Engineers, Editor Mark Davies, Tata McGraw Hill, 2010.


19/9/24.
PROFESSOR & HEAD
Department of Aeronautical Engineering
S.J.C. Institute of Technology
CHICKBALLAPUR-582101



Estd: 1986

|| Jai Sri Gurudev ||
Sri Adichunchanagiri Shikshana Trust *

SJC INSTITUTE OF TECHNOLOGY

Chickballapur – 562 101

Department of Aeronautical Engineering LESSON PLAN

SUBJECT TITLE	FLIGHT VEHICLE DESIGN		
SUBJECT TYPE	CORE /ELECTIVE		
SUBJECT CODE	17AE82		
ACADEMIC YEAR	2018 (ODD SEMESTER)	BATCH	2016-2020
SCHEME	CBCS scheme (Effective from the academic year 2016 -2017)		
SEMESTER & SECTION	VIII		
IA MARKS	40	EXAM MARKS	100
NUMBER OF LECTURE HOURS/WEEK	3	TOTAL NUMBER OF LECTURE HOURS	50
FACULTY NAME	Prof. Deepa M S	NO. OF TIMES HANDLED	First time
COURSE LEARNING OBJECTIVES: This course will enable students to			
1. Comprehend the Flight Vehicle Design process			
2. Acquire the knowledge of vehicle configuration and structural components			
3. Understand the stability and Control & subsystems			
Course Outcomes: At the end of this course, students are able to:			
CO1	Estimate the overall weight and the effect of wing loading of an aircraft for different flight regimes (L5)		
CO2	Design a structure of fuselage, suitable wing tail arrangement for a given aircraft (L5)		
CO3	Predict the suitable propulsion system and sub-systems for a given aircraft (L4)		
CO4	Calculate the stability characteristics and size of the control surfaces for an aircraft (L4)		

CO-PO MATRIX

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	-	-	-	1	1	2	1	1	3	2
CO2	3	3	3	3	-	-	-	1	1	2	1	1	3	2
CO3	3	3	3	3	-	-	-	1	1	2	1	1	3	2
CO4	3	3	3	3	-	-	-	1	1	2	1	1	3	2

Note: Justification of CO-PO mapping

- Assignments picked from NPTEL course is given as assignment problems covering all the design aspects of an aircraft

DELIVERY PLAN WITH DETAILS

MODULE - 1							
Lecture #	Topic	Mode of Delivery (Pls Tick ✓)				Date of Delivery	COs Covered
		1	2	3	4		
1.	Overview of Design Process: Introduction, Requirements, Phases of design		✓			22/4/21	CO1
2.	Conceptual Design Process, Initial Sizing,		✓			22/4/21	CO1
3.	Take-off weight build up, Empty weight estimation,		✓			23/4/21	CO1
4.	Fuel fraction estimation, Take-off weight calculation.		✓			29/4/21	CO1
5.	Thrust to Weight Ratio & Wing Loading: Thrust to Weight Definitions, Statistical Estimate of T/W		✓			29/4/21	CO1
6.	Thrust matching, Spread sheet in design, Wing Loading and its effect on Stall speed		✓			30/4/21	CO1
7.	Take-off Distance, Catapult take-off, and Landing Distance		✓			6/5/21	CO1
8.	Wing Loading for Cruise, Loiter, Endurance,		✓			6/5/21	CO1
9.	Instantaneous Turn rate, Sustained Turn rate		✓			7/5/21	CO1
10.	Climb, & Glide, Maximum ceiling.		✓			10/5/21	CO1
Textbook : Aircraft Design-A conceptual approach by Daniel Raymer and chapter : 2, 3 and 5							
Signatures	Faculty:	#HOURS			Allotted	Taken	
	HoD:						
Remarks					10	8	
MODULE - 2							
Lecture #	Topic	Mode of Delivery (Pls Tick ✓)				Date of Delivery	COs Covered
		1	2	3	4		
11.	Configuration Layout & loft: Conic Lofting, Conic Fuselage Development		✓			13/5/21	CO2
12.	Conic Shape Parameter, Wing-Tail Layout & Loft. Aerofoil Linear Interpolation		✓			13/5/21	CO2
13.	Aerofoil Flat-wrap Interpolation. Wing aerofoil layout-flap wrap. Wetted area determination.		✓			13/5/21	CO2
14.	Special considerations in Configuration Layout:		✓			13/5/21	CO2
15.	Aerodynamic, Structural, Detectability. Crew station, Passenger, and Payload arrangements.		✓			20/5/21	CO2
16.	Design of Structural Components: Fuselage, Wing, Horizontal & Vertical Tail.		✓			20/5/21	CO2
17.	Spreadsheet for fuselage design. Tail arrangements, Horizontal & Vertical Tail Sizing		✓			20/5/21	CO2
18.	Tail Placement. Loads on Structure.		✓			20/5/21	CO2
19.	V-n Diagram, Gust Envelope. Loads distribution		✓			21/5/21	CO2
20.	Shear and Bending Moment analysis.		✓			21/5/21	CO2
Textbook : Aircraft Design-A conceptual approach by Daniel Raymer and chapter: 7,8,9 and 14							
Signatures	Faculty:	#HOURS			Allotted	Taken	

HoD:	<i>[Signature]</i> 21/5/21.	10	<i>[Signature]</i>
------	--------------------------------	----	--------------------

Remarks

MODULE - 3

Lecture #	Topic	Mode of Delivery (Pls Tick ✓)				Date of Delivery	COs Covered
		1	2	3	4		
21.	Engine Selection & Flight Vehicle Performance Turbojet Engine Sizing, Installed Thrust Correction		✓			3/6/21	CO3
22.	Spread Sheet for Turbojet Engine Sizing.		✓			3/6/21	CO3
23.	Propeller Propulsive System		✓			3/6/21	CO3
24.	Propeller design for cruise. Take-off		✓			3/6/21	CO3
25.	Landing & Enhanced Lift Devices, Ground Roll		✓			4/6/21	CO3
26.	Rotation, Transition		✓			4/6/21	CO3
27.	Climb, Balanced Field Length,		✓			10/6/21	CO3
28.	Landing Approach		✓			10/6/21	CO3
29.	Braking, Spread Sheet for Take-off and Landing.		✓			10/6/21	CO3
30.	Enhanced lift design -Passive & Active. Spread Sheet		✓			10/6/21	CO3

Textbook : Aircraft Design-A conceptual approach by Daniel Raymer and chapter :6, 10 and 17

Signatures	Faculty:	#HOURS	Allotted	Taken
	HoD:		10	9

Remarks

MODULE - 4

Lecture #	Topic	Mode of Delivery (Pls Tick ✓)				Date of Delivery	COs Covered
		1	2	3	4		
31.	Static Stability & Control Longitudinal Static Stability, Pitch Trim Equation		✓			11/6/21	CO4
32.	Effect of Airframe components on Static Stability. Lateral stability.		✓			17/6/21	CO4
33.	Contribution of Airframe components. Directional Static stability		✓			17/6/21	CO4
34.	Contribution of Airframe components.		✓			17/6/21	CO4
35.	Aileron Sizing,		✓			18/6/21	CO4
36.	Rudder Sizing. Spread Sheets		✓			18/6/21	CO4
37.	Flying qualities.		✓			24/6/21	CO4
38.	Cooper Harper Scale		✓			24/6/21	CO4
39.	Environmental constraints		✓			25/6/21	CO4
40.	Aerodynamic requirements.		✓			25/6/21	CO4

Textbook: Aircraft Design-A conceptual approach by Daniel Raymer and chapter : 16,

Signatures	Faculty:	#HOURS	Allotted	Taken
	HoD:		10	5

Remarks



Estd: 1986

|| Jai Sri Gurudev ||
Sri Adichunchanagiri Shikshana Trust ®

SJC INSTITUTE OF TECHNOLOGY

Chickballapur – 562 101

Department of Aeronautical Engineering

QUESTION BANK

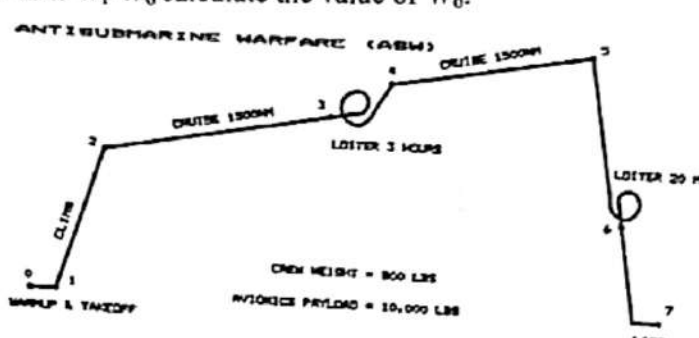
SUBJECT TITLE	FLIGHT VEHICLE DESIGN		
SUBJECT TYPE	CORE /ELECTIVE		
SUBJECT CODE	17AE82		
ACADEMIC YEAR	2018 (ODD SEMESTER)	BATCH	2016-2020
SCHEME	CBCS scheme (Effective from the academic year 2016 -2017)		
SEMESTER	VIII		
FACULTY NAME and DESIGNATION	Prof. Deepa M S		

Module -I			
Q. No.	Questions	Bloom's LL	COs
1	Explain about the overview of the design process and phases of aircraft design	L2	CO1
2	Explain in detail the conceptual design phase in aircraft design	L2	CO1
3	Explain Thrust Matching & also explain about the Thrust -To Weight Ratio and Wing Loading	L2	CO1
4	With the help of neat diagrams describe various mission profiles and explain mission segment weight fractions for simple cruise	L2	CO1
5	What is Design and explain the Design Wheel?	L2	CO1
6	Derive the relationship between the thrust - to - weight ratio and wing loading of an aircraft in climb, cruise, turn, landing and maximum ceiling	L3	CO1
7	Explain about takeoff - weight calculation and derive an expression.	L3	CO1

Deepa M S
28/6/21

(V Rajan)
28/6/21

PROFESSOR & HEAD
Department of Aeronautical Engineering
S.J.C. Institute of Technology
CHICKBALLAPUR-562101
Page | 1

<p>8</p>	<p>Consider a typical military bomber of $L/D = 16$, warm up and takeoff fuel fraction is 0.97, climb fuel fraction is 0.985, Cruise $R = 1500$ Nm or $R = 2778$ km, $C = 0.5$ /hr, $V = 0.6M$ (same for both the cruise conditions) 1st Loiter $E = 3$ hrs, $C = 0.4$/hr, 2nd Loiter $E = 20$ mins, landing fuel fraction W_f/W_0. From W_f/W_0 calculate the value of W_0.</p>  <p>FIG: 1.8 – Sample Mission Profile</p>	<p>L4</p>	<p>CO1</p>																																										
<p>9</p>	<p>An airplane under design has the following features: Weight of payload + crew = 26000 N Estimated fuel fraction (W_f/W_0) = 0.387 Empty weight fraction (W_e/W_0) = $0.837 W_0^{-0.7}$ where, W_0 is in Newtons. Obtain the gross weight (W_0) of the airplane</p>	<p>L4</p>	<p>CO1</p>																																										
<p>10</p>	<p>The empty weight fraction (W_e/W_0) is expressed as $A W_0^c$. A look at the values of 'c' shows that it is negative for all types airplanes i.e. if empty weight goes up the empty weight fraction decreases or the gross weight goes up by a larger amount. Explain this. (Hint: Consider what happens to the fuel required when the empty weight goes up)</p> <table border="1" data-bbox="319 1254 1149 1612"> <thead> <tr> <th>$W_f/W_0 = A W_0^c K_{sw}$</th> <th>A</th> <th>C</th> </tr> </thead> <tbody> <tr> <td>Sailplane—unpowered</td> <td>0.86</td> <td>-0.05</td> </tr> <tr> <td>Sailplane—powered</td> <td>0.91</td> <td>-0.05</td> </tr> <tr> <td>Homebuilt—metal/wood</td> <td>1.19</td> <td>-0.09</td> </tr> <tr> <td>Homebuilt—composite</td> <td>0.99</td> <td>-0.09</td> </tr> <tr> <td>General aviation—single engine</td> <td>2.36</td> <td>-0.18</td> </tr> <tr> <td>General aviation—twin engine</td> <td>1.51</td> <td>-0.10</td> </tr> <tr> <td>Agricultural aircraft</td> <td>0.74</td> <td>-0.03</td> </tr> <tr> <td>Twin turboprop</td> <td>0.96</td> <td>-0.05</td> </tr> <tr> <td>Flying boat</td> <td>1.09</td> <td>-0.05</td> </tr> <tr> <td>Jet trainer</td> <td>1.59</td> <td>-0.10</td> </tr> <tr> <td>Jet fighter</td> <td>2.34</td> <td>-0.13</td> </tr> <tr> <td>Military cargo/bomber</td> <td>0.93</td> <td>-0.07</td> </tr> <tr> <td>Jet transport</td> <td>1.02</td> <td>-0.06</td> </tr> </tbody> </table> <p>K_{sw} = variable sweep constant = 1.04 if variable sweep = 1.00 if fixed sweep</p>	$W_f/W_0 = A W_0^c K_{sw}$	A	C	Sailplane—unpowered	0.86	-0.05	Sailplane—powered	0.91	-0.05	Homebuilt—metal/wood	1.19	-0.09	Homebuilt—composite	0.99	-0.09	General aviation—single engine	2.36	-0.18	General aviation—twin engine	1.51	-0.10	Agricultural aircraft	0.74	-0.03	Twin turboprop	0.96	-0.05	Flying boat	1.09	-0.05	Jet trainer	1.59	-0.10	Jet fighter	2.34	-0.13	Military cargo/bomber	0.93	-0.07	Jet transport	1.02	-0.06	<p>L5&L6</p>	<p>CO1</p>
$W_f/W_0 = A W_0^c K_{sw}$	A	C																																											
Sailplane—unpowered	0.86	-0.05																																											
Sailplane—powered	0.91	-0.05																																											
Homebuilt—metal/wood	1.19	-0.09																																											
Homebuilt—composite	0.99	-0.09																																											
General aviation—single engine	2.36	-0.18																																											
General aviation—twin engine	1.51	-0.10																																											
Agricultural aircraft	0.74	-0.03																																											
Twin turboprop	0.96	-0.05																																											
Flying boat	1.09	-0.05																																											
Jet trainer	1.59	-0.10																																											
Jet fighter	2.34	-0.13																																											
Military cargo/bomber	0.93	-0.07																																											
Jet transport	1.02	-0.06																																											

<i>Module -2</i>			
<i>Q. No.</i>	<i>Questions</i>	<i>Bloom's LL</i>	<i>COs</i>
1	Describe the process of development of configuration layout from conceptual sketch. List the outcomes of it.	L2	CO2
2	Explain Conic Lofting. Describe the process of conic lofting used in the development of wing and fuselage	L2	CO2
3	With the help of relevant sketches explain the determination of Wetted Area and Volume distribution in Configuration layout.	L2	CO2
4	List The special factors considered in the configuration layout of ana aircraft and explain each in detail.	L2	CO2
5	List the additional considerations in the design of military aircrafts and describe in detail.	L2	CO2
6	With the help of neat sketches explain the design of crew station in an aircraft layout.	L2	CO2
7	With the help of neat sketches explain the design of Passenger compartment in an aircraft layout.	L3	CO2
8	With the help of neat sketches explain the design of Cargo Provisions in an aircraft layout.	L3	CO2
9	With the help of neat sketches explain the design of Weapon Carriage in an aircraft layout.	L3	CO2
10	Mention the advantages and disadvantages in the following cases. (i) Side-by-side and tandem seating arrangement in a trainer airplane. (ii) Circular cross-section for the cabin of a transport airplane. (iii) Conventional tail, T-tail and V-tail configurations of empennage. (iv) Jet airplanes with engines (a) held by pylons on wings (b) located in wing root and (c) located on rear fuselage. (v) Tractor propeller and pusher propeller. (vi) Retractable and non-retractable landing gear.	L5&L6	CO2

<i>Module -3</i>			
<i>Q. No.</i>	<i>Questions</i>	<i>Bloom's LL</i>	<i>COs</i>
1	Describe the process of Rubber Engine sizing involved in initial sizing of the aircraft	L1	CO3
2	Describe the process of Fixed Engine sizing involved in initial sizing of the aircraft	L1	CO3
3	Explain the major options available for engine selection with illustrations of propulsion system limits.	L1	CO3
4	Describe Jet Engine Integration and the method involved in estimating the installed thrust.	L2	CO3
5	Briefly explain the corrections involved in the installed engine thrust with relevant equations and graphs.	L2	CO3
6	Briefly describe the Piston Engine Performance, Propeller Performance and Piston-Prop Thrust Corrections.	L2	CO3
7	Describe Turboprop performance in brief.	L3	CO3
8	Estimate Takeoff Analysis and explain all the segments involved during takeoff with neat sketch.	L3	CO3
9	Estimate Landing Analysis and explain all the segments involved during takeoff with equations and neat sketch.	L3	CO3
10	Describe the various methods involved in the process of enhancing lift. List the disadvantages.	L2	CO3
11	Explain various design spreadsheet obtained in the estimation of lift enhancement, takeoff and landing analysis.	L2	CO3
12	Mention the range of flight speeds for which the following engines are used. (a) Piston engine-propeller combination (b) Turboprop engine (c) Turbofan engine (d) Turbojet engine - Justify the answer	L4	CO3
13	Consider a turboprop airplane with (a) two engines mounted on each wing half, (b) high wing configuration, (c) tricycle landing gear. What are the considerations for the following (i) Spanwise location of engines? (ii) Location of nacelle relative to wing leading edge. (iii) Location of landing gear main wheels attached to nacelles or in pods attached to fuselage.	L5 & L6	CO3

Module -4

Q. No.	Questions	Bloom's LL	COs
1	Describe longitudinal static stability and explain the main contributors of pitching moment with a neat sketch.	L2	CO4
2	With the help of neat sketches explain the various trim equations for pitching moment.	L2	CO4
3	Describe lateral static stability and explain the main contributors of pitching moment with a neat sketch.	L2	CO4
4	With the help of neat sketches explain the various trim equations for rolling and yaw moments.	L2	CO4
5	Briefly describe the methods of Aileron, Elevator and Rudder sizing with relevant sketches and equations	L2	CO4
6	With the help of a Cooper-Harper scale explain the various flying qualities of an aircraft.	L2	CO4
7	Explain the various environmental constraints involved in the operation of a flight.	L3	CO4

Module -5

Q. No.	Questions	Bloom's LL	COs
1	With the help of relevant sketches explain the operation of Flight Control systems	L2	CO3
2	Describe Landing gear arrangements and the subsystems involved in the design of landing gears	L2	CO3
3	Brief describe the following subsystems of aircraft i) Hydraulics system ii) Electrical system iii) Pneumatic system iv) Auxiliary/Emergency Power v) Communication system	L2	CO3

4	With the help of a neat schematic diagram describe the cabin pressurization and air conditioning systems.	L2	CO3
5	Briefly explain propulsion and fuel system integration in an aircraft.	L2	CO3
6	Describe the process of material selection criteria in aircraft design.	L2	CO3
7	From internet (www.google.com), study the activities of these companies especially, in the areas of airplane design and manufacture. (a) Embraer of Brazil. (b) Bombardier of Canada. (c) Chengdu aircraft industrial corporation of China. (d) Dassault aviation of France. (e) Hindustan aeronautics limited of India. (f) Israel aerospace industries of Israel. (g) Aermacchi of Italy	L4	CO3

Note:

- Questions shall be framed by consolidating comprehensively from the following sources
 - Exercise problems of text books/ references
 - Previous year question VTU exam Question paper. (Mark the year/exam beside the question)
 - Questions by Experts during Interview/Academic Audit
 - Internet sources/ other Universities examination question papers.
 - Own / experience.
 - Gate questions mentioning the year.
- Questions shall follow all the Bloom's learning levels with appropriate action verbs
- There shall be a total of 50 questions considering 10 questions from each module, of which, 3 questions each at L1 and L2, 2 questions at L3, 1 question each at L4 and L5/L6.
- Ensure the coverage of all Cos.



Estd: 1986

|| Jai Sri Gurudev ||
Sri Adichunchanagiri Shikshana Trust ®

SJC INSTITUTE OF TECHNOLOGY

Chickballapur – 562 101

Department of Aeronautical Engineering ASSIGNMENT

SUBJECT TITLE	FLIGHT VEHICLE DESIGN		
SUBJECT TYPE	CORE /ELECTIVE		
SUBJECT CODE	17AE82		
ACADEMIC YEAR	2018 (ODD SEMESTER)	BATCH	2016-2020
SCHEME	CBCS scheme (Effective from the academic year 2016 -2017)		
SEMESTER	VIII		
FACULTY NAME and DESIGNATION	Prof. Deepa M S		

<i>Module -1</i>			
<i>Q. No.</i>	<i>Questions</i>	<i>Bloom's LL</i>	<i>COs</i>
1	<p>Consider a typical military bomber of $L/D = 16$, warm up and takeoff fuel fraction is 0.97, climb fuel fraction is 0.985, Cruise $R = 1500 \text{ Nm}$ or $R = 2778 \text{ km}$, $C = 0.5 / \text{hr}$, $V = 0.6M$ (same for both the cruise conditions) 1st Loiter $E = 3 \text{ hrs}$, $C = 0.4 / \text{hr}$, 2nd Loiter $E = 20 \text{ mins}$, landing fuel fraction W_f/W_o. From W_f/W_o calculate the value of W_o.</p> <p>FIG: 1.8 – Sample Mission Profile</p>	L4	CO1
2	<p>An airplane under design has the following features: Weight of payload + crew = 26000 N Estimated fuel fraction $(W_f/W_o) = 0.387$ Empty weight fraction $(W_e/W_o) = 0.837 W_o^{-0.7}$ where, W_o is in Newtons. Obtain the</p>	L4	CO1

Deepa
28/6/2021

Page | 1
Rajini
28/6/21

gross weight (W_0) of the airplane																																														
3	The empty weight fraction (W_e/W_0) is expressed as $A W_0^c$. A look at the values of 'c' shows that it is negative for all types airplanes i.e. if empty weight goes up the empty weight fraction decreases or the gross weight goes up by a larger amount. Explain this. (Hint: Consider what happens to the fuel required when the empty weight goes up)		L5&L6	CO1																																										
	$W_e/W_0 = A W_0^c K_{sw}$ <table border="1"> <thead> <tr> <th></th> <th>A</th> <th>C</th> </tr> </thead> <tbody> <tr> <td>Sailplane—unpowered</td> <td>0.86</td> <td>-0.05</td> </tr> <tr> <td>Sailplane—powered</td> <td>0.91</td> <td>-0.05</td> </tr> <tr> <td>Homebuilt—metal/wood</td> <td>1.19</td> <td>-0.09</td> </tr> <tr> <td>Homebuilt—composite</td> <td>0.99</td> <td>-0.09</td> </tr> <tr> <td>General aviation—single engine</td> <td>2.36</td> <td>-0.18</td> </tr> <tr> <td>General aviation—twin engine</td> <td>1.51</td> <td>-0.10</td> </tr> <tr> <td>Agricultural aircraft</td> <td>0.74</td> <td>-0.03</td> </tr> <tr> <td>Twin turboprop</td> <td>0.96</td> <td>-0.05</td> </tr> <tr> <td>Flying boat</td> <td>1.09</td> <td>-0.05</td> </tr> <tr> <td>Jet trainer</td> <td>1.59</td> <td>-0.10</td> </tr> <tr> <td>Jet fighter</td> <td>2.34</td> <td>-0.13</td> </tr> <tr> <td>Military cargo/bomber</td> <td>0.93</td> <td>-0.07</td> </tr> <tr> <td>Jet transport</td> <td>1.02</td> <td>-0.06</td> </tr> </tbody> </table>					A	C	Sailplane—unpowered	0.86	-0.05	Sailplane—powered	0.91	-0.05	Homebuilt—metal/wood	1.19	-0.09	Homebuilt—composite	0.99	-0.09	General aviation—single engine	2.36	-0.18	General aviation—twin engine	1.51	-0.10	Agricultural aircraft	0.74	-0.03	Twin turboprop	0.96	-0.05	Flying boat	1.09	-0.05	Jet trainer	1.59	-0.10	Jet fighter	2.34	-0.13	Military cargo/bomber	0.93	-0.07	Jet transport	1.02	-0.06
		A			C																																									
	Sailplane—unpowered	0.86			-0.05																																									
	Sailplane—powered	0.91			-0.05																																									
	Homebuilt—metal/wood	1.19			-0.09																																									
	Homebuilt—composite	0.99			-0.09																																									
	General aviation—single engine	2.36			-0.18																																									
	General aviation—twin engine	1.51			-0.10																																									
	Agricultural aircraft	0.74			-0.03																																									
	Twin turboprop	0.96			-0.05																																									
	Flying boat	1.09			-0.05																																									
	Jet trainer	1.59			-0.10																																									
Jet fighter	2.34	-0.13																																												
Military cargo/bomber	0.93	-0.07																																												
Jet transport	1.02	-0.06																																												
K_{sw} = variable sweep constant = 1.04 if variable sweep = 1.00 if fixed sweep																																														

Module -2

Q. No.	Questions	Blooms LL	COs
1	Mention the advantages and disadvantages in the following cases. (i) Side-by-side and tandem seating arrangement in a trainer airplane. (ii) Circular cross-section for the cabin of a transport airplane. (iii) Conventional tail, T-tail and V-tail configurations of empennage. (iv) Jet airplanes with engines (a) held by pylons on wings (b) located in wing root and (c) located on rear fuselage. (v) Tractor propeller and pusher propeller. (vi) Retractable and non-retractable landing gear.	L5&L6	CO2

Module -3

Q. No.	Questions	Bloom's LL	COs
4	Mention the range of flight speeds for which the following engines are used. (a) Piston engine-propeller combination (b) Turboprop engine (c) Turbofan engine (d) Turbojet engine - Justify the answer	L4&L5	CO3

5	Consider a turboprop airplane with (a) two engines mounted on each wing half, (b) high wing configuration, (c) tricycle landing gear. What are the considerations for the following (i) Spanwise location of engines? (ii) Location of nacelle relative to wing leading edge. (iii) Location of landing gear main wheels attached to nacelles or in pods attached to fuselage.	L4&L5	CO3
---	--	-------	-----

Module -5

Q. No.	Questions	Bloom's LL	COs
1	From internet (www.google.com), study the activities of these companies especially, in the areas of airplane design and manufacture. (a) Embraer of Brazil. (b) Bombardier of Canada. (c) Chengdu aircraft industrial corporation of China. (d) Dassault aviation of France. (e) Hindustan aeronautics limited of India. (f) Israel aerospace industries of Israel. (g) Aermacchi of Italy	L4	CO3

**Internal Test Question paper format- 2018 Scheme**

Name of the staff: Mrs. Deepa M S

Date: 28.05.2021

Signature:  28/5/21Reviewer's Signature:  28/5/21

NOTE: Only the following information's to be given to the students.

**S.J.C. INSTITUTE OF TECHNOLOGY
DEPARTMENT OF AERONAUTICAL ENGINEERING**

Test : I

Semester: VIII

Subject Name & Code: FLIGHT VEHICLE DESIGN – 17AE82

Date: 29.06.2021

Timings: 9:30 to

11:00 pm

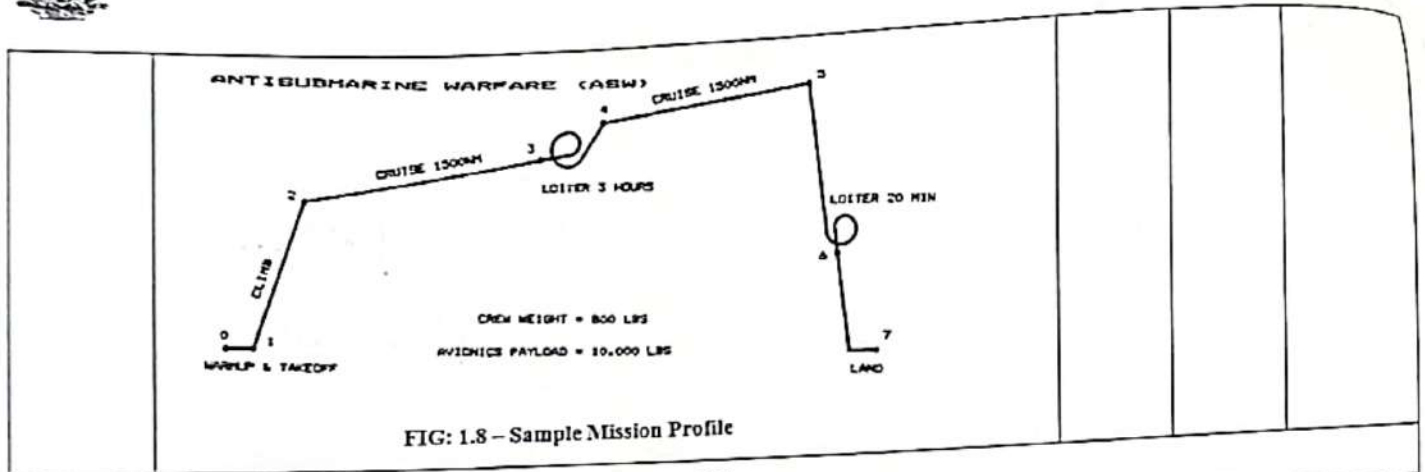
Duration: 90 minutes

Max Marks: 50

Instructions

Answer FIVE questions by choosing one question from each

Question Number		Marks	COs	LEVEL
1	Explain about the overview of the design process and phases of aircraft design	10	CO1	L2
OR				
2.	Explain in detail the conceptual design phase in aircraft design	10	CO1	L2
3	With the help of neat diagrams describe various mission profiles and explain mission segment weight fractions for simple cruise	10	CO1	L2
OR				
4	Explain Thrust Matching & also explain about the Thrust -To Weight Ratio and Wing Loading	10	CO1	L2
5	Consider a typical military bomber of $L/D = 16$, warm up and takeoff fuel fraction is 0.97, climb fuel fraction is 0.985, Cruise $R = 1500$ Nm or $R = 2778$ km, $C = 0.5$ /hr, $V = 0.6M$ (same for both the cruise conditions) 1. Loiter $E = 3$ hrs, $C = 0.4$ /hr, 2. Loiter $E = 20$ mins, landing fuel fraction W/W_0 . From W/W_0 , calculate the value of W_0 .	10	CO1	L4



OR

6	An airplane under design has the following features: Weight of payload + crew = 26000 N Estimated fuel fractions (W/W_0) = 0.387 Empty weight fraction (W_e/W_0) = 0.837 where, W_0 is in Newton. Obtain the gross weight (W_0) of the airplane	10	CO1	L4
7.	Explain Conic Lofting. Describe the process of conic lofting used in the development of wing and fuselage	10	CO2	L2
OR				
8.	List the additional considerations in the design of military aircrafts and describe in detail.	10	CO2	L3
9.	Describe the process of development of configuration layout from conceptual sketch. List the outcomes of it.	10	CO2	L3
OR				
10	With the help of relevant sketches explain the determination of Wetted Area and Volume distribution in Configuration layout.	10	CO2	L3

Course Outcomes: At the end of this course, students are able to:

CO1	Estimate the overall weight and the effect of wing loading of an aircraft for different flight regimes (L5)
CO2	Design a structure of fuselage, suitable wing tail arrangement for a given aircraft (L5)
CO3	Predict the suitable propulsion system and sub-systems for a given aircraft (L4)
CO4	Calculate the stability characteristics and size of the control surfaces for an aircraft (L4)

DEPARTMENT: AERONAUTICAL ENGINEERING

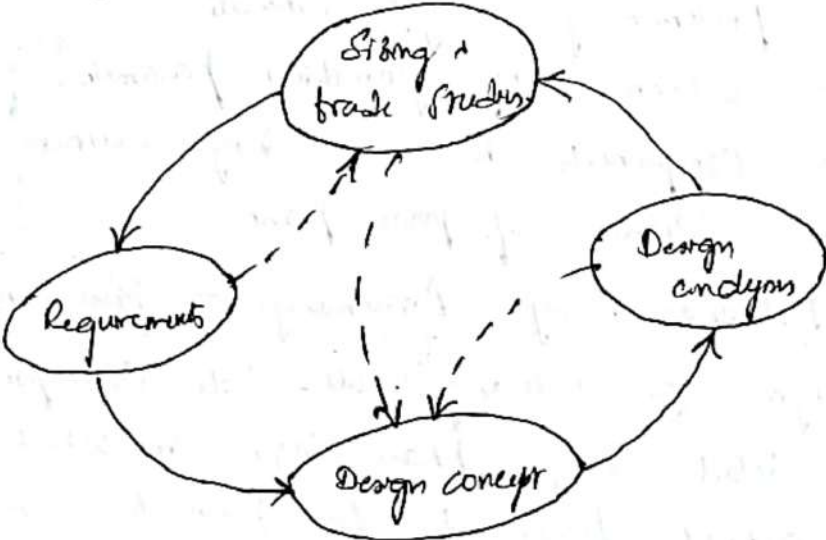
Scheme & Solutions- TEST- I/II/III

Date: 28/6/2024

Semester: VIII

Subject Title: Flight Vehicle Design

Subject Code: TAE82

Question Number	Solution	Marks Allocated
1.	<p>* Design is an iterative process and effort as shown in the design wheel. Requirements are set by prior design trade studies. Concepts are developed to meet the requirements. Design analysis frequently point towards new concepts and technologies, which can initiate a whole new design effort. All these activities are equally important in producing a good aircraft concept.</p>  <p>* Aircraft design can be broken into three major phases i.e. Conceptual design ii) Preliminary design iii) Detail Design</p>	<p>-2-</p>



Subject Title: Flight Vehicle Design

Subject Code: 17A82

Question Number	Solution	Marks Allocated
	<p>- <u>Conceptual Design</u>: - It is the primary focus when the basic questions of configuration arrangement, size and weight performance are answered. New ideas and problems emerge as a design is investigated.</p> <p>- <u>Preliminary Design</u>: This stage of design process aims at producing a broken containing preliminary drawings, stating the estimated operational capabilities of the airplane. This stage includes:</p> <ul style="list-style-type: none"> - Preliminary weight estimate - Selection of geometrical parameters of main components based on design criteria - Selection of power plant <p>- <u>Detailed Design</u>: Arriving at a favorable design for entering full-scale development the detail design phase begins in which the actual pieces to be fabricated are designed. Detailed design is also called production design, and involves how airplane can be fabricated, ease of manufacturing etc.</p>	<p>-2-</p> <p>-2-</p> <p>-2-</p> <hr/> <p>10</p>

17 AEE 82

Subject Title: Flight Vehicle Design

Subject Code: 17 AEE 82

Question Number	Solution	Marks Allocated
d.	<p>* Aircraft conceptual design will usually begin with either a specific set of design requirements established by the prospective customer or a company. Design requirements include parameters such as the altitude range and payload, takeoff & landing distances, manoeuvrability and speed requirements.</p> <p>* The design requirements also include a set of civil or military design specifications. These include landing sink speed, stall speed, structural design limits, pilot outside vision angle, reserve fuel etc.,.</p> <p>* The 'front view' drawing provides the information needed to develop an initial design layout. The three-view layout is done on a convenient scale such as $1/10$, $1/20$, $1/40$ or $1/100$ on a computer aided design system.</p> <p>* This initial layout is analysed to determine if it really will perform the mission as indicated by the front view drawing. Actual aerodynamics, weights & installed propulsion characteristics are analysed.</p> <p>* The end product of all this will be an aircraft design that can be passed to the preliminary design phase.</p>	<p>- 2-</p> <p>- 2-</p> <p>- 2-</p> <p>- 2-</p>
		10



Subject Title: Flight Vehicle Design

Subject Code: 17AE001

Question Number	Solution	Marks Allocated
3.	<p>* Typical mission profiles for various types of aircraft are shown in fig. The simple cruise mission is used for many transport & general aviation designs. * Other missions are more complex. The typical air superiority mission includes a cruise out, a combat consisting of either a certain number of turns or certain number of minutes at maximum power, a weapon drop, a cruise back, and a loiter.</p> <p>* Mission segments weight fractions for simple cruise: - warmup & takeoff - climb - cruise - loiter & - land</p>	<p>-2-</p> <p>-2-</p> <p>-2-</p> <p>-4-</p>
		10

Subject Title: Flight vehicle Design

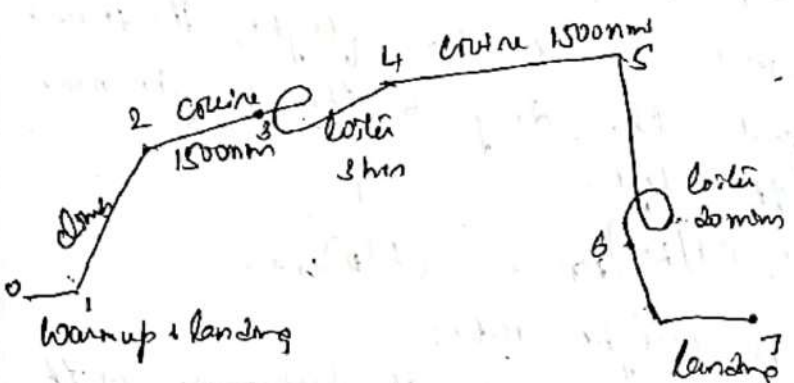
Subject Code: 17AES2

Question Number	Solution	Marks Allocated
4.	<p><u>Thrust matching</u>: For aircraft design, for effective during cruise, a better initial estimate of the required T/W can be obtained by 'thrust matching'. This is the comparison of the selected engine's thrust available during cruise to the estimated aircraft drag.</p> <p>- In level unaccelerated flight, the thrust must equal the drag & the weight must equal the lift.</p> $\therefore (T/W)_{cruise} = \frac{1}{(L/D)_{cruise}}$ <p><u>Thrust to weight ratio</u>:</p> <p>- T/W directly affects the performance of the aircraft. Higher T/W will accelerate more quickly, climb more rapidly, reach a maximum speed & sustain higher turn rates.</p> <p>- The large engine will consume more fuel which will drive up the aircraft's takeoff gross weight to perform the mission.</p> $\frac{T}{W} = \left(\frac{550hp}{V} \right) \left(\frac{hp}{W} \right)$ <p><u>Wing loading</u>: It is the weight of the aircraft divided by the area of the reference wing. As with the thrust-to-weight ratio, wing loading takes off wing loading at combat or other flight conditions</p>	<p>-2-</p> <p>-2-</p> <p>-2-</p> <p>-1-</p> <p>-2-</p>



Subject Title: Flight Vehicle Design

Subject Code: 17AES2

Question Number	Solution	Marks Allocated
	<p>- The aircraft is larger if wing loading is reduced, this may improve performance but the additional drag & empty weight due to the larger wing will mean taking more weight to perform the mission.</p>	-1-
5.	 <p> $N_0 = \frac{W_{crew} + W_{payload}}{1 - W_H/W_0 - W_E/W_0}$ </p> <p> $W_{crew} = 800 \text{ lbs}$ </p> <p> $W_{payload} = 10,000 \text{ lbs}$ </p> <p> TO find W_H/W_0 </p> <p> $\frac{W_H}{W_0} = 1.06 (1 - W_E/W_0)$ </p> <p> $\frac{W_6}{W_0} = \frac{W_H}{W_0} = \frac{W_1}{W_0} \cdot \frac{W_2}{W_1} \cdot \frac{W_3}{W_2} \cdot \frac{W_4}{W_3} \cdot \frac{W_5}{W_4} \cdot \frac{W_6}{W_5} \cdot \frac{W_H}{W_6}$ </p> <p> if <u>warm up</u> & <u>Takeoff</u> </p> <p> $\frac{W_1}{W_0} = \underline{\underline{0.99}}$ from horizontal mission segment weight. </p>	

17 AUG 2017

Subject Title: Flight Vehicle Design

Subject Code: 17AE82

Question Number	Solution	Marks Allocated
	<p>ii) Climb: $W_2/W_1 = 0.985$ From table 1.2, $\frac{W_2}{W_1} = 0.985$</p> <p>iii) <u>Cruise</u> $\frac{W_3}{W_2} = e^{-\frac{Rc}{v \times W_0}}$</p> <p>R - range = 1500 nm = 9114000 ft c - Specific fuel consumption Assuming high-bypass turbofan engine c for cruise = 0.5 c for loiter = 0.4</p> <p>v - velocity = 0.6 x M_{CR} - given = 0.6 x velocity of sound = 0.6 x 994.8 = 596.9 ft/s</p> <p>$\therefore \frac{W_3}{W_2} = e^{-\left[\frac{9114000 \times 0.5}{596.9 \times 0.866 \times 16} \right]}$ $e^{-0.095} = 0.91$</p> <p>iv) <u>loiter</u>: $E = 3 \text{ hours} = 10,800 \text{ s}$ $c = 0.4 \text{ /hr} = 0.000111 \text{ /s}$ $H_{D \text{ loiter}} = H_{D \text{ max}} = 16$ $\frac{W_4}{W_3} = e^{-\left[\frac{E \cdot c}{H_{D \text{ loiter}}} \right]} = e^{-\left[\frac{10,800 \times 0.000111}{16} \right]}$ $e^{-0.075} = 0.9277$</p> <p>v) <u>Cruise</u>: $W_5/W_4 = 0.91$</p> <p>vi) <u>loiter</u>: $E = 20 \text{ min} = 1200 \text{ s}$ $c = 0.000111 \text{ /s}$ $H_{D \text{ loiter}} = H_{D \text{ max}} = 16$</p>	



Subject Title: Flight Vehicle Design

Subject Code: 17AE82

Question Number	Solution	Marks Allocated															
	<p> $\frac{W_6}{W_5} = e^{-kC/40} = 0.9917$ very landing $\frac{W_7}{W_6} = 0.995$ (from table) $\frac{W_7}{W_0} = \frac{W_1}{W_0} \times \frac{W_2}{W_1} \times \frac{W_3}{W_2} \times \frac{W_4}{W_3} \times \frac{W_5}{W_4} \times \frac{W_6}{W_5} \times \frac{W_7}{W_6}$ $= 0.7242$ $\frac{W_4}{W_0} = 1.06 (1 - W_7/W_0) = 1.06 (1 - 0.7242)$ $\frac{W_4}{W_0} = \underline{\underline{0.2923}}$ $\frac{W_e}{W_0} = A W_0^C K_5$ Empty weight fraction vs W_0 from table for military cargo/bomber $A = 0.93, C = 0.07, K_5 = 1.00$ <small>fixed empty</small> $\frac{W_e}{W_0} = 0.93 W_0^{-0.07}$ $\therefore W_0 = \frac{W_{crew} + W_{payload}}{1 - \frac{W_4}{W_0} - \frac{W_e}{W_0}}$ $= \frac{800 + 10000}{1 - 0.2923 - 0.93 W_0^{-0.07}}$ </p> <table border="1" data-bbox="383 1635 1197 1971"> <thead> <tr> <th>W_0 guess</th> <th>W_e/W_0</th> <th>W_0 calculated</th> </tr> </thead> <tbody> <tr> <td>50,000</td> <td>0.426</td> <td>66,264</td> </tr> <tr> <td>60,000</td> <td>0.420</td> <td>64,864</td> </tr> <tr> <td>59,200</td> <td>0.4209</td> <td>64,958</td> </tr> <tr> <td>59,000</td> <td>0.4210</td> <td>64,952</td> </tr> </tbody> </table>	W_0 guess	W_e/W_0	W_0 calculated	50,000	0.426	66,264	60,000	0.420	64,864	59,200	0.4209	64,958	59,000	0.4210	64,952	
W_0 guess	W_e/W_0	W_0 calculated															
50,000	0.426	66,264															
60,000	0.420	64,864															
59,200	0.4209	64,958															
59,000	0.4210	64,952															

Subject Title: High Vehicle Design

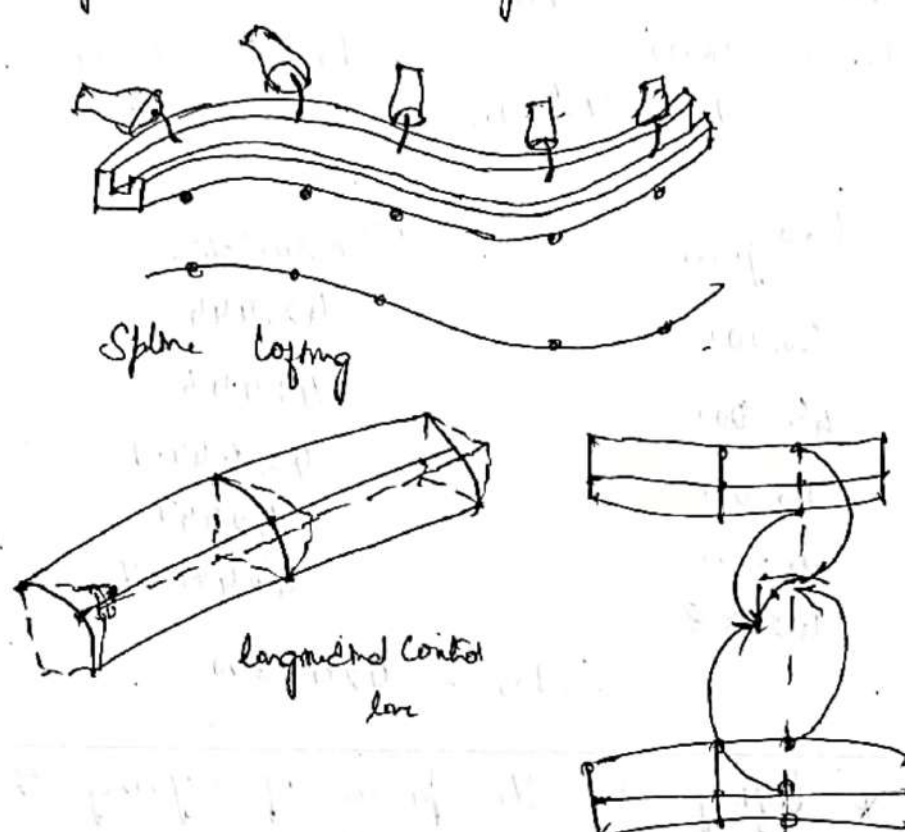
Subject Code: 17AE52

Question Number	Solution	Marks Allocated		
6.	<p> W_n of payload + crew = 26000 N $\frac{W_n}{W_0} = 0.287, \frac{W_n}{W_0} = 0.827 W_0^{-0.7}$ $W_0 = \frac{26000}{1 - 0.287 - W_n/W_0} \quad W_0 = \frac{26000}{1 - 0.287 - 0.827 W_0^{-0.7}}$ </p> <table border="0" style="width: 100%;"> <tr> <td style="vertical-align: top;"> W_0 guess 50,000 45,000 44,000 43,000 42,448 </td> <td style="vertical-align: top; text-align: center;"> W_0 calculated 42,444 46,446 42,447.9 42,447 42,447.7 </td> </tr> </table> <p style="text-align: center;">$\therefore W_0 = \underline{\underline{42448 N}}$</p>	W_0 guess 50,000 45,000 44,000 43,000 42,448	W_0 calculated 42,444 46,446 42,447.9 42,447 42,447.7	
W_0 guess 50,000 45,000 44,000 43,000 42,448	W_0 calculated 42,444 46,446 42,447.9 42,447 42,447.7			
7.	<p> * Lofting is the process of defining the external geometry of the aircraft. "production lofting" the process detailed form of lofting, provides an well mathematical definition of the entire aircraft including such minor details as the intake to exhaust ducts for the air conditioning. - 2 - </p> <p> - Overall lofting of the fuselage, wing, tails & nacelles must be defined separately to show that these major components will properly enclose the required material - 2 - </p>			



Subject Title: Flight Vehicle Design

Subject Code: 17AET2

Question Number	Solution	Marks Allocated
	<p>Internal Components and fuel tanks while providing a smooth aerodynamic contour.</p>  <p>* Explanation of wing and fuselage using cross section development from longitudinal control line and flat wrap method</p> <p>* Explanation of the fuselage lofting and cone fuselage development</p>	<p>-2-</p> <p>-2-</p> <p>-2-</p> <p>-10-</p>

17AE72

Subject Title: Flight Vehicle Design

Subject Code: 17AE82

Question Number	Solution	Marks Allocated
8.	<p>A list of additional considerations in the design of military aircraft</p> <ul style="list-style-type: none"> i) Radar detectability ii) Infra-red detectability iii) Visual detectability iv) Aural signature <p>v) A explanation of each additional consideration</p> <p><u>Radar detectability</u>: A radar installation consists of a transmitter antenna that sends a directed beam of electromagnetic wave and receiver antenna which picks up the faint radio wave that bounces off the object.</p> <p>Radar cross section and stealth technology requires proper shaping of the airplane - buried engines (no nacelles), flying wing, intake on top of the airplane, exhaust with 2D nozzle</p> <p><u>Infra-red detectability</u>: Guidance to air to air and ground-to-air missiles is based on seeking source of Infra-red (IR) radiation. Source of IR - engine exhaust, hot parts of airplane, aerodynamic heating, at high speeds, solar IR radiation reflected by sun</p>	<p>-2-</p> <p>-2-</p>



Subject Title: Flight Vehicle Design

Subject Code: 17AE82

Question Number	Solution	Marks Allocated
	<p>- Radiation from engine exhaust can be reduced i) having a bypass engine as power plant ii) Increase mixing & lower temperature by using 2-D nozzle</p> <p><u>Visual Detectability</u>: - depends on the size of the airplane & color. Aircraft can also be detected in night by glow of engine exhaust</p> <p><u>Camouflage Schemes</u> are used to avoid detection</p> <p>- reduced by glint suppression</p> <p><u>Aural Signatures</u>: Noise is important for criterion as well as military aircraft. They have airborne ordnance. Noise is caused by airflow shear layers, primarily due to the engine exhaust.</p> <p>- Noise level inside the cabin has to be minimal. Achieved by suitable noise insulation, & reducing the clearance between Cabin and the propeller.</p>	<p>- 2 -</p> <p>- 2 -</p> <p>- 2 -</p> <hr/> <p>10.</p>
<p>9.</p>	<p>* Explanation of the process of aircraft conceptual design includes numerous statistical analytical predictions, and numerical optimizations. The product of aircraft design is a drawing. A detailed analysis is conducted to revise</p>	<p>- 2 -</p>

Subject Title: Flight Vehicle Design

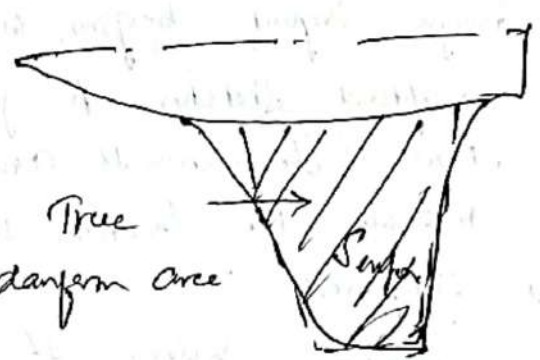
Subject Code: 17AE82

Question Number	Solution	Marks Allocated
	<p>the aircraft and determine its actual performance. This detailed analysis is done concerning</p>	-2-
	<p>* End products of configurations layout are design drawings of several types as well as the geometric information required for further analysis</p>	-2-
	<p>* The design layout begins with a number of conceptual sketches. A good sketch will show the overall aerodynamic concept and indicate the location of the major internal components.</p>	-2-
	<p>* They should include the landing gear, crew station, payload or passenger compartment, propulsion system, fuel tanks and any unique internal components such as large radar</p>	-2-
	<p>* Conceptual sketches are not usually shown to anybody after the actual layout is developed, but may be used among the design engineers to discuss novel ideas</p>	-2-
		10



Subject Title: Flight Vehicle Design

Subject Code: 18AE02

Question Number	Solution	Marks Allocated
10.	<p>* Average wetted area (Swet) the total exposed surface area can be visualized as the area of the enclosed parts of the aircraft.</p> <p>The wetted area must be calculated for drag estimation, as it is the major contribution to friction drag.</p>  <p>if $M_c < 0.05$ Swept = d.003 Sweptness</p> <p>if $M_c > 0.05$ Swept = Sweptness $[1.972 + 0.52(M_c)]$</p> <p>* volume distribution $Vol = \frac{d.4 (A_{top})(A_{side})}{HL}$</p> <p>Aircraft internal volume can be used as a measure of the reasonableness of a new design by comparing the volume to</p>	<p>- 2-</p> <p>- 2-</p> <p>- 2-</p> <p>- 2-</p> <p>- 2-</p>

Staff Rajaram
29/6/2020
Incharge

(V Rajan)
Rajaram

(V Rajan)
PROFESSOR & HEAD
Department of Aeronautical Engineering
S.J.C. Institute of Technology
CHICKBALLAPUR-562115

S J C INSTITUTE OF TECHNOLOGY
DEPARTMENT OF AERONAUTICAL ENGINEERING
FOR THE ACADEMIC YEAR 2020-21 (EVEN SEM)
FIRST INTERNAL ASSESSMENT - FLIGHT VEHICLE DESIGN - 17AE82

SL NO.	USN	NAME	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total (50)	Marks (30)
1	ISJ17AE002	ABHIJEET	10			9	10		9		10		48	29
2	ISJ17AE004	AKASH H A	10		9			9		10		9	47	28
3	ISJ17AE005	AKSHATA GUNDETI	9		10		10			9	9		47	28
4	ISJ17AE006	AMRUTHA R	9			6		5		9	9		38	23
5	ISJ17AE009	AVESODDIN SIDDIQUI FAHIMODDIN SIDDIQUI	9		9			9	8			8	43	26
6	ISJ17AE010	BASAVARAJU B N	9		9		6			8		9	41	25
7	ISJ17AE011	BHARATH B	9			9	10		9		7		44	26
8	ISJ17AE012	C H LOKESH	10		9		10		9		10		48	29
9	ISJ17AE013	CHIANDANA N	10			9		10		9	10		48	29
10	ISJ17AE014	ERAGOWDA H G	9		9		10			10		9	47	28
11	ISJ17AE015	FIRDOSE BANU	9		9		9			10		2	39	23
12	ISJ17AE016	JAHANAVI R	9		10		9			9	9		46	28
13	ISJ17AE017	JASON JEEVAN C J	9			10	10			9		10	48	29
14	ISJ17AE018	KOTA SHREYAS PRAKASH	9		9		10			9	7		44	26
15	ISJ17AE019	KUMAR S	8			7	8			7	4		34	20

16	ISJ17AE020	LOCHANA B M	9			9	10			10	10		48	29
17	ISJ17AE021	MAGDUM ARIHANT RAJGONDA	9			8		9	9			7	42	25
18	ISJ17AE022	MAHESH D N	9			10	10		9		9		47	28
19	ISJ17AE023	MALATHI S	9			10	9			9	9		46	28
20	ISJ17AE024	MANOJ C		9		8	10			8		6	41	25
21	ISJ17AE025	MEGHA MANNIKERI	10		10		10			9	9		48	29
22	ISJ17AE027	MOHAN D C	8			8		5		7	8		36	22
24	ISJ17AE028	NETHRA J		10	9		10			9	10		48	29
25	ISJ17AE029	NIHAL N	9		9			10		9		9	46	28
26	ISJ17AE030	NIKHIL M	9			10		10		9		10	48	29
27	ISJ17AE031	NISHAT MOMIN	10		9			9		9		9	46	28
28	ISJ17AE032	PAVAN KALYAN B V	9			9	10			9		8	45	27
29	ISJ17AE033	PRUTHVIJA P	9		9			8		9		9	44	26
30	ISJ17AE035	SACHINREDDY	9			9		4		9	9		40	24
31	ISJ17AE036	SANDEEP D			9		9						18	11
32	ISJ17AE037	SANDEEP N	9		9		9			9		9	45	27
33	ISJ17AE039	SATISH KUMAR H		6		8	7		6		8		35	21

34	ISJ17AE040	SIDDHARTH CHANDRA CHOUDHARY	9			8		8	5			8	38	23
35	ISJ17AE041	SRIDEVI M HERLE	10		9		9		6		5		39	23
36	ISJ17AE042	SUBHAM	9		9		5		9			8	40	24
37	ISJ17AE043	SUBHRA BERA	9		9		10			9	8		45	27
38	ISJ17AE044	SUHAS C	9		9		10			9		10	47	28
39	ISJ17AE048	NANDAN KUMAR .S	8		8		9			8	8		41	25
40	ISJ17AE049	GURUMALLESH	8			6	7			5	6		32	19
41	ISJ16AE002	ABHILASH M		6		7	9			8	8		38	23

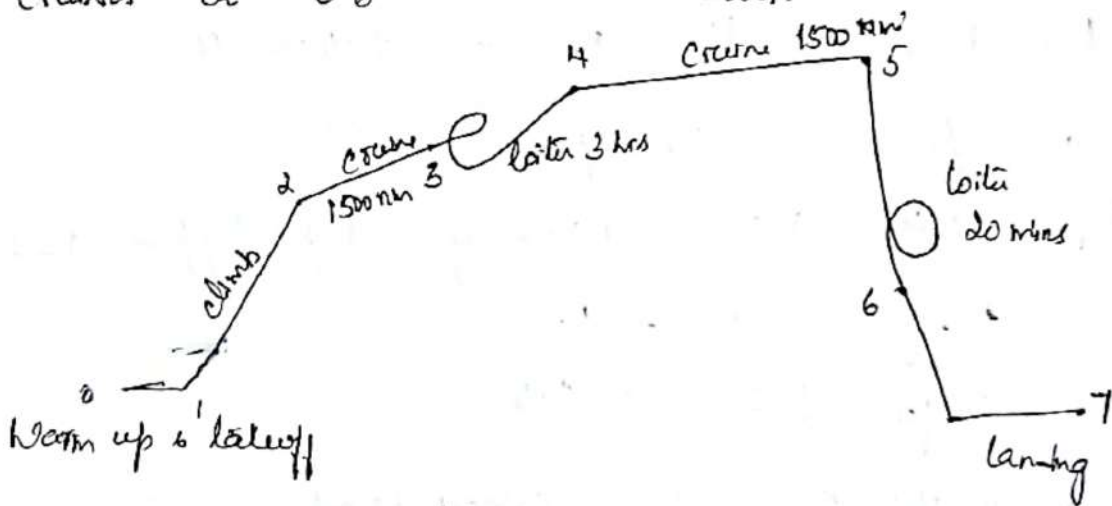
Defence
Staff Incharge

(V Rajan)
6/7/21
PROFESSOR & HEAD
Department of Aeronautical Engineering
S.J.C. Institute of Technology
CHICKBALLAPUR-502101

Flight Vehicle Design - 17AE82

Module - I . Problems

①. Fig illustrates the mission requirement for a hypothetical Anti-Submarine Warfare (ASW) aircraft. The key requirement is the ability to loiter for three hours at a distance of 1500 n.mi from the takeoff point. While loitering on-station this type of aircraft uses sophisticated electronic equipment to detect and track submarines. For the sizing example, this equipment is assumed to weigh 10,000 lbs. Also a four man crew is required, totalling 800 lbs. The aircraft cruises at 0.6 Mach number.



Soln:..

N.K.T

$$W_0 = \frac{W_{crew} + W_{payload}}{1 - W_H/W_0 - W_E/W_0}$$

$W_{crew} = 800 \text{ lbs}$

$W_{payload} = 10,000 \text{ lbs}$

} Given

To find W_T/W_0

W.K.T $\frac{W_T}{W_0} = 1.06 (1 - W_T/W_0)$

$$W_T/W_0 = W_T/W_0 = W_1/W_0 \cdot \frac{W_2}{W_1} \cdot \frac{W_3}{W_2} \cdot \frac{W_4}{W_3} \cdot \frac{W_5}{W_4} \cdot \frac{W_6}{W_5} \cdot \frac{W_7}{W_6}$$

∴ Warm up + Take off

$$\frac{W_1}{W_0} = \text{for Warmup + Takeoff}$$

$$= 0.97$$

From Table 1.2 - Historical Mission Segment Weight fractions

$$\text{Warmup + Takeoff} = \underline{0.97}$$

∴ Climb: $\frac{W_2}{W_1} = \underline{0.985}$

From Table 1.2, for climb $W_i/W_{i-1} = 0.985$

∴ Cruise: $\frac{W_3}{W_2} = e^{-R \cdot C/V \cdot W_0}$

R: Range = 1500 nmi = 9114000 ft

C - Specific fuel consumption

From Table 1.3, Assuming High-bypass Turbofan engine

e - for Cruise = 0.5

C - for Cruise = 0.4

V - Velocity = 0.6 × Mach number - given

$$= 0.6 \times \text{Velocity of sound}$$

$$= 0.6 \times 994.8$$

$$= 596.9 \text{ ft/s}$$

$$\therefore \frac{W_3}{W_2} = e^{-\left[\frac{9114000 \times 0.5}{596.9 \times 0.866 \times 16} \right]}$$

$$e^{-(-0.095)}$$

$H_D \text{ max}$ is assumed as 16.

(2)

For a JH engine.

$$H_D \text{ cruise} = 0.866 H_D \text{ max} = 0.866 \times 16$$

$$H_D \text{ loiter} = H_D \text{ max} = \underline{\underline{13.856}}$$

$$\frac{W_3}{W_2} = e^{-0.095} = \underline{\underline{0.91}}$$

47 Loiter: $E = 3 \text{ hours} = 10,800 \text{ s.}$

$$C = 0.4 \text{ hr} = 0.000111 \text{ s.}$$

$$H_D \text{ loiter} = H_D \text{ max} = 16$$

$$\begin{aligned} \frac{W_4}{W_3} &= e^{[-Ec/H_D]} \\ &= e^{[-10,800 \times 0.000111 / 16]} \\ &= e^{-0.075} \end{aligned}$$

$$\frac{W_4}{W_3} = \underline{\underline{0.9277}}$$

57 Cruise $\frac{W_5}{W_4}$ - Same as no (3)

$$\therefore \frac{W_5}{W_4} = 0.91$$

67 Loiter: $E = 20 \text{ mins} = 1200 \text{ s.}$

$$C = 0.000111 \text{ s}$$

$$H_D \text{ loiter} = H_D \text{ max} = 16.$$

$$\frac{W_6}{W_5} = e^{[-Ec/H_D]} = e^{[-1200 \times 0.000111 / 16]}$$

$$\frac{W_6}{W_5} = e^{-0.008325}$$

$$= \underline{\underline{0.9917}}$$

\rightarrow landing $\frac{W_7}{W_6} = \underline{\underline{0.995}}$
 from Table 1.2

$$\frac{W_i}{W_{i-1}} \text{ for landing} = 0.995$$

$$\frac{W_7}{W_0} = \frac{W_1}{W_0} \times \frac{W_2}{W_1} \times \frac{W_3}{W_2} \times \frac{W_4}{W_3} \times \frac{W_5}{W_4} \times \frac{W_6}{W_5} \times \frac{W_7}{W_6}$$

$$= 0.97 \times 0.985 \times 0.91 \times 0.9277 \times 0.91 \times 0.9917 \times 0.995$$

$$= 0.7242$$

$$\therefore \frac{W_7}{W_0} = 1.06 (1 - \frac{W_7}{W_0})$$

$$= 1.06 (1 - 0.7242)$$

$$\frac{W_7}{W_0} = \underline{\underline{0.2923}}$$

$$\frac{W_e}{W_0} = A W_0^C K V_s$$

From Table 1.1: Empty weight fraction v/s W_0
 for Military Cargo/Bomber

$$A = 0.93, \quad C = -0.07$$

\hookrightarrow $K V_s = 1.00$ if fuel sweep

$$\therefore \frac{W_e}{W_0} = 0.93 W_0^{-0.07}$$

$$\therefore W_0 = \frac{W_{crew} + W_{payload}}{1 - W_H/W_0 - W_E/W_0}$$

(3)

$$= \frac{800 + 10000}{1 - 0.2923 - 0.93 W_0^{-0.07}}$$

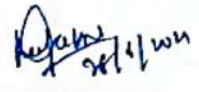
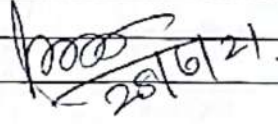
W_0 given	W_E/W_0	W_0 calculated
50,000	0.43606	66,264
60,000	0.4305	64,864
59,200	0.4309	64,958
54,000	0.4310	65,052

It is clear that the value of W_E/W_0 & W_0 calculated for different values of W_0 is so that W_0 given & W_0 calculated is approximately same.

**Internal Test Question paper format- 2018 Scheme**

Name of the staff: Mrs. Deepa M S

Date: 28.06.2021

Signature: Reviewer's Signature: 

NOTE: Only the following information's to be given to the students.

**S.J.C. INSTITUTE OF TECHNOLOGY
DEPARTMENT OF AERONAUTICAL ENGINEERING**

Test : II

Semester: VIII

Subject Name & Code: FLIGHT VEHICLE DESIGN - 17AE82

Date: 29.06.2021

Timings: 9:30 to

11:00 pm

Duration: 90 minutes

Max Marks: 50

Instructions**Answer FIVE questions by choosing one question from each**

Question Number		Marks	COs	LEVEL
1	Describe the process of wing design involved in the process of conceptual design of an aircraft.	10	CO2	L3
OR				
2.	Describe the process of fuselage design involved in the process of conceptual design of an aircraft.	10	CO2	L3
3	With the help of relevant sketches explain the various types of wing vertical locations.	10	CO2	L2
OR				
4	Explain the different types of wingtips and tail arrangements used with sketches.	10	CO2	L2
5	Explain the major options available for engine selection with illustrations of propulsion system limits.	10	CO3	L2
OR				
6	Briefly explain the corrections involved in the installed engine thrust with relevant equations and graphs.	10	CO3	L2
7.	Describe Jet Engine Integration and the method involved in estimating the installed thrust.	10	CO3	L3
OR				
8.	Describe the process of Fixed Engine sizing involved in initial sizing	10	CO3	



	of the aircraft			
9.	Estimate Takeoff Analysis and explain all the segments involved during takeoff with neat sketch.	10	CO3	L3
OR				
10	Describe the various methods involved in the process of enhancing lift. List the disadvantages.	10	CO3	L3

Course Outcomes: At the end of this course, students are able to:	
CO1	Estimate the overall weight and the effect of wing loading of an aircraft for different flight regimes (L5)
CO2	Design a structure of fuselage, suitable wing tail arrangement for a given aircraft (L5)
CO3	Predict the suitable propulsion system and sub-systems for a given aircraft (L4)
CO4	Calculate the stability characteristics and size of the control surfaces for an aircraft (L4)

DEPARTMENT: AERONAUTICAL ENGINEERING

Scheme & Solutions- TEST- I/II/III

Date: 28/6/2021

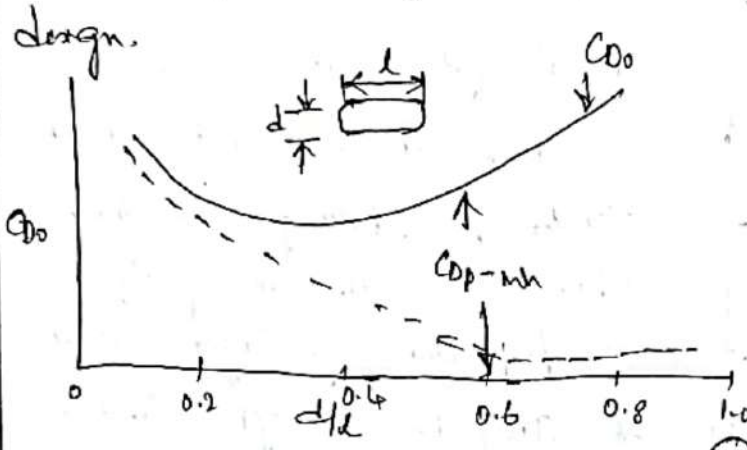
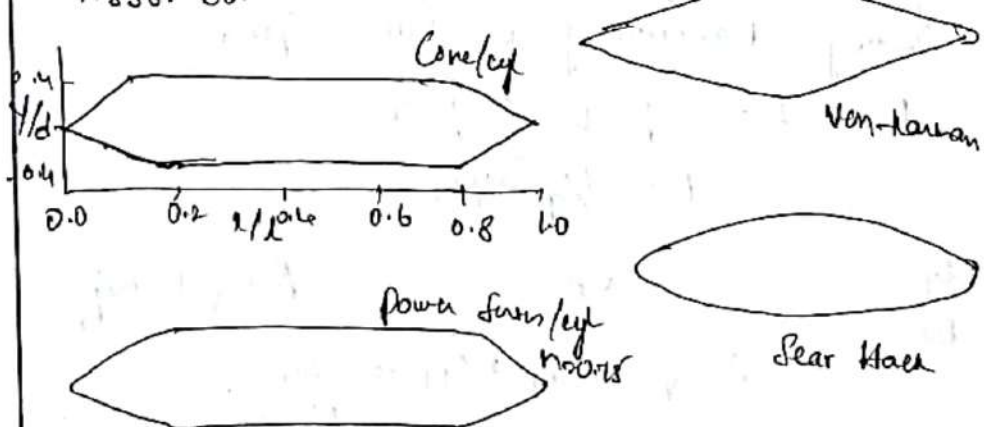
Semester: V/III

Subject Title: Flight Vehicle Design Subject Code: 17AES 2

Question Number	Solution	Marks Allocated
1.	<p>* Explanation of the process of wing design as per the flow</p> <div style="display: flex; align-items: center;"> <div style="flex: 1;"> <pre> graph TD A[Airfoil Selection] --> B[Paper tests Selection] B --> C[Wing sweep angle selection] C --> D[Wing lift coefficient] D --> E[Wing Drag estimate] </pre> </div> <div style="flex: 2;"> <p>* Aerofoil selection - Drive Chman at low & high Mach numbers, Stalling characteristics where a gentle loss of lift is preferable for light aircraft.</p> <p>* Drag in aircraft climb & cruise conditions, when the lift to drag ratio should be as high as possible & at higher Mach numbers.</p> <p>Span influences the following - climb, cruise and weight.</p> <p>Wing area influences - Cruise Drag, Takeoff & landing, manoeuvring & stall speed</p> $W = L = qSC_L = qS C_L$ $C_L = 1/q (W/S)$ $\frac{dC_L}{d\alpha} = \frac{2\pi A}{d + \sqrt{4 + (A\beta)^2 (1 + \frac{\tan^2 \epsilon \sin^2 \epsilon}{\beta^2})}}$ $\beta = \sqrt{1 - M_{eff}^2}$ </div> </div>	<p>- 2 -</p> <p>- 2 -</p> <p>- 2 -</p> <p>- 2 -</p> <hr/> <p>10</p>

Subject Title: Flight Vehicle Design

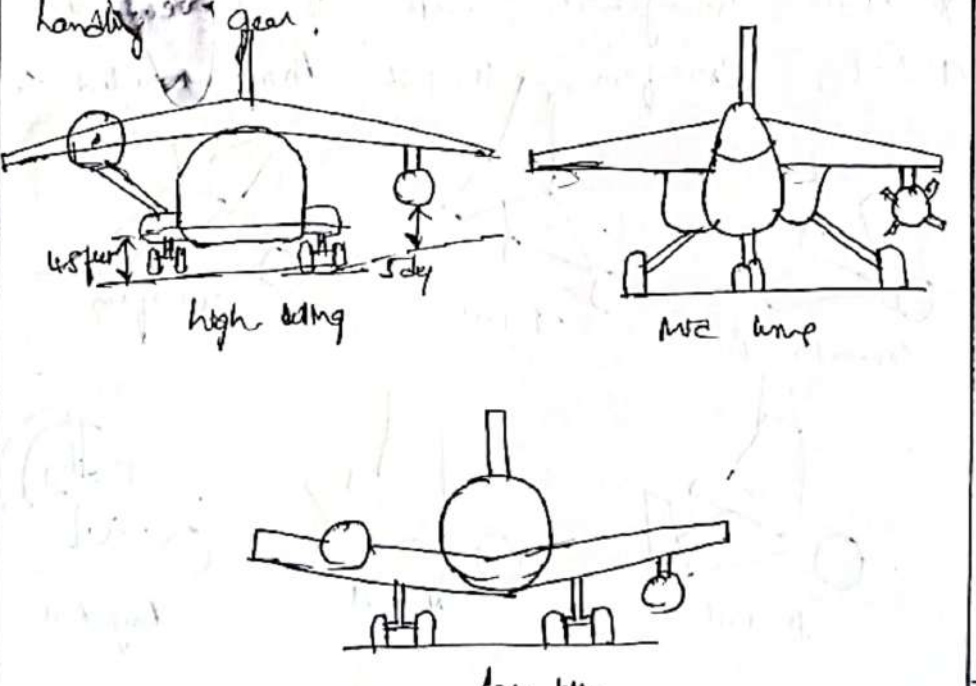
Subject Code: 17AE22

Question Number	Solution	Marks Allocated																								
2.	<p>* Explanation of the design process involved in fuselage design and details of seating arrangements & compartment design.</p>  <p>* Length ratio for different passenger transport aircraft</p> <table border="1" data-bbox="351 1164 1244 1523"> <thead> <tr> <th>Subsonic</th> <th>d/l</th> <th>Supersonic</th> <th>d/l</th> </tr> </thead> <tbody> <tr> <td>457-200</td> <td>0.08</td> <td>Concorde</td> <td>0.05</td> </tr> <tr> <td>767-200</td> <td>0.10</td> <td>747-144</td> <td>0.05</td> </tr> <tr> <td>777</td> <td>0.10</td> <td></td> <td></td> </tr> <tr> <td>MD-11</td> <td>0.10</td> <td></td> <td></td> </tr> <tr> <td>A330-300</td> <td>0.08</td> <td></td> <td></td> </tr> </tbody> </table> 	Subsonic	d/l	Supersonic	d/l	457-200	0.08	Concorde	0.05	767-200	0.10	747-144	0.05	777	0.10			MD-11	0.10			A330-300	0.08			<p>-2-</p> <p>-2-</p> <p>-2-</p> <p>-2-</p> <p>10</p>
Subsonic	d/l	Supersonic	d/l																							
457-200	0.08	Concorde	0.05																							
767-200	0.10	747-144	0.05																							
777	0.10																									
MD-11	0.10																									
A330-300	0.08																									

17AE82

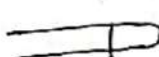
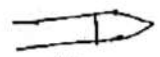


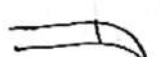

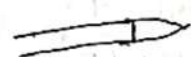

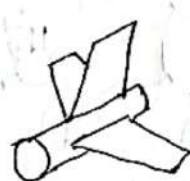

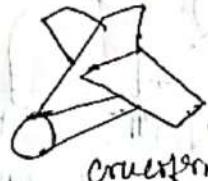
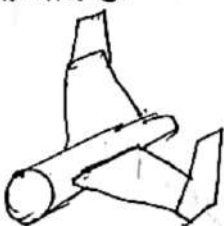
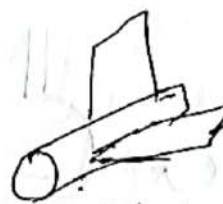
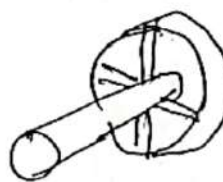
Subject Title: Flight Vehicle Design

Subject Code: 17AE82

Question Number	Solution	Marks Allocated
2.	<p><u>Wing Vertical Location:</u></p> <p>The wing vertical location with respect to the fuselage is generally set by the real world environment in which the aircraft will operate. All high-speed commercial aircraft are of low-wing design, military transport aircraft designed to similar mission profiles and payload weights are all of high-wing design. The major benefit of a high wing is that it allows placing the fuselage close to the ground.</p> <p>For military transport aircraft such as the C-8 and C-141 this allows loading & unloading the cargo without special ground handling gear.</p> 	<p>-2</p> <p>-2</p> <p>-2-</p> <p>-2-</p>
		16

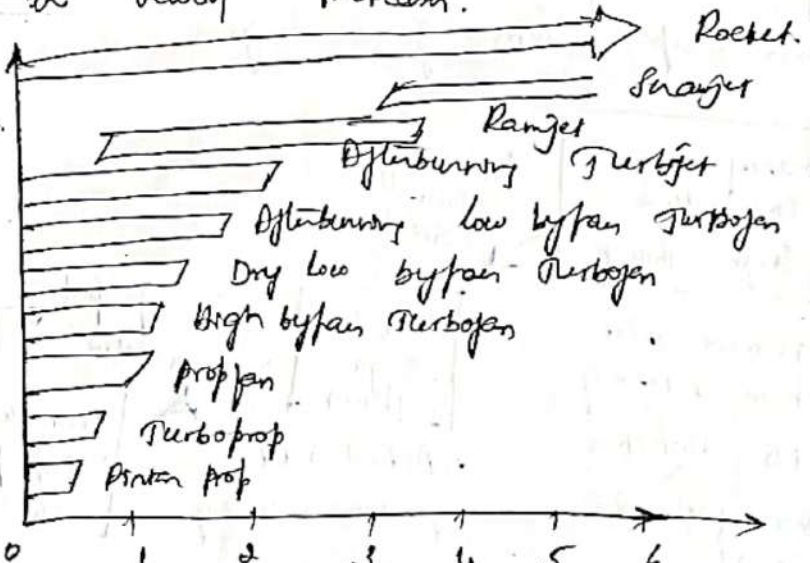


Subject Title: Flight Vehicle Design

Question Number	Solution	Marks Allocated
4.	<p>* Wing tips has two effects upon subsonic aerodynamic performance. The tip shape affects the aerodynamic wetted area, and on the lateral spacing of the tip vortices.</p> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>Rounded</p> </div> <div style="text-align: center;">  <p>Sharp</p> </div> <div style="text-align: center;">  <p>Cut-off</p> </div> <div style="text-align: center;">  <p>Hoerner</p> </div> </div> <div style="display: flex; justify-content: space-around; align-items: flex-start; margin-top: 10px;"> <div style="text-align: center;">  <p>Drooped</p> </div> <div style="text-align: center;">  <p>Aft Swept</p> </div> <div style="text-align: center;">  <p>Cut-off forward swept</p> </div> <div style="text-align: center;">  <p>end plate</p> </div> </div> <p>* Explanation of the above types of wing tips such as rounded, sharp, cut-off, Hoerner, drooped, end plate etc.</p> <p>* Tail arrangements such as conventional, T-tail, cruciform, H-tail boom rounded etc</p> <div style="display: flex; justify-content: space-around; align-items: flex-start; margin-top: 10px;"> <div style="text-align: center;">  <p>Conventional</p> </div> <div style="text-align: center;">  <p>T-tail</p> </div> <div style="text-align: center;">  <p>cruciform</p> </div> </div> <div style="display: flex; justify-content: space-around; align-items: flex-start; margin-top: 10px;"> <div style="text-align: center;">  <p>H-tail</p> </div> <div style="text-align: center;">  <p>N-tail</p> </div> <div style="text-align: center;">  <p>Rogo tail</p> </div> </div>	<p style="text-align: center;">-2-</p> <p style="text-align: center;">-2-</p> <p style="text-align: center;">-2-</p> <p style="text-align: center;">-2-</p>
		10

Subject Title: Flight Vehicle Design

Subject Code: 17AEE82

Question Number	Solution	Marks Allocated
5.	<p>The figure shows the major options for selection of propulsion systems. The piston prop was the first form of aircraft propulsion which are mainly limited to light aircraft and some agricultural airplanes now. They are cheap & have the lowest fuel consumption. They are heavy and produce a lot of noise and vibration & the propeller loses efficiency as the velocity increases.</p>  <p>* The selection of the type of propulsion system - piston prop, turbo prop, turbofan turbojet, ramjet - will usually be from the design requirements. Aircraft maximum speed limits the choices as shown in the above figure</p>	<p>-2-</p> <p>-2-</p> <p>-4-</p> <p>-2-</p>
		10

17AEE82



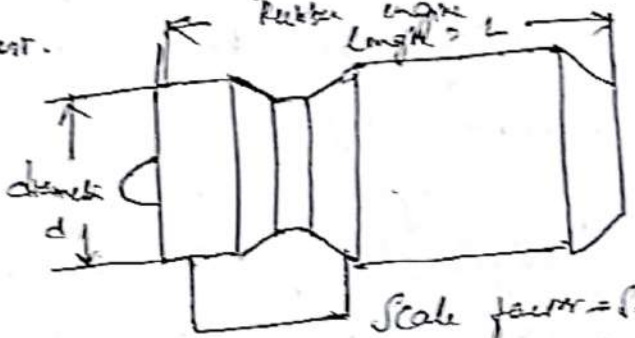
Subject Title: High Vehicle Design

Subject Code: 17AE82

Question Number	Solution	Marks Allocated
6.	<p>* The Statistical methods for estimating installed thrust and specific fuel consumption for jet engines are suitable for initial design and performance estimates.</p> <p>* It is assumed that uninstalled engine data is available, either from an engine manufacturer, a preliminary cycle analysis or a judge factor approach based upon some given engine</p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>Manufacturers Uninstalled Engine Thrust</p> <p>↓ Less Installation Corrections</p> <p>Installed Engine Thrust</p> <p>↓ Less Propulsion related drag</p> <p>Installed net propulsion force</p> </div> <ul style="list-style-type: none"> - Assumed inlet pressure recovery - No interaction - manufacturer nozzle - Spc applies to this thrust - Actual inlet pressure recovery - Bleed to power extraction - Distortion effects - Actual nozzle performance - Inlet drag - Nozzle drag - Throttle dependent - Wm drag <p>$T = \dot{m} (V_e - V_0) + A_e (P_e - P_0)$</p> <p style="margin-left: 100px;">$P_e > P_0$</p> <p style="margin-left: 150px;">$T = T_{ref} \frac{\dot{m}}{\dot{m}_{ref}}$</p>	<p>- 2</p> <p>- 2</p> <p>- 4-</p> <p>- 2 -</p>

Subject Title: Flight Vehicle Design

Subject Code: 17AE02

Question Number	Solution	Marks Allocated
7.	<p><u>X Jet Engine Integration.</u> If the aircraft is designed using an existing off the shelf engine the dimensions are obtained from the manufacturer. If a rocket engine is being used, the dimensions for the engine must be obtained by scaling from some nominal engine size by. Scale factor is required to provide the desired thrust.</p>  <p>Scale factor = $(sf = \frac{T_{req}}{T_{nom}})$</p> <p>$L = L_{nominal} (sf)^{0.6}$</p> <p>$D = D_{nominal} (sf)^{0.5}$</p> <p>$W = W_{nominal} (sf)^{1.1}$ W - weight</p> <p>Nbr of turbojet engines T - Takeoff Thrust</p> <p>$N = 0.0044 T^{1.1} e^{-0.045 BPR}$ BPR - Bypass ratio</p> <p>$L = 0.22 T^{0.4} M^{0.2}$ M - max Mach number</p> <p>$D = 0.393 T^{0.5} e^{(0.04 BPR)}$</p> <p>$sf_{max T} = 0.67 e^{(-0.12 BPR)}$ Cruise at</p> <p>$T_{cruise} = 0.60 T^{0.9} e^{0.02 BPR}$ 36,000 ft & 0.9M</p>	<p>- 2 -</p> <p>- 2 -</p> <p>- 2 -</p> <p>- 2 -</p>
		10



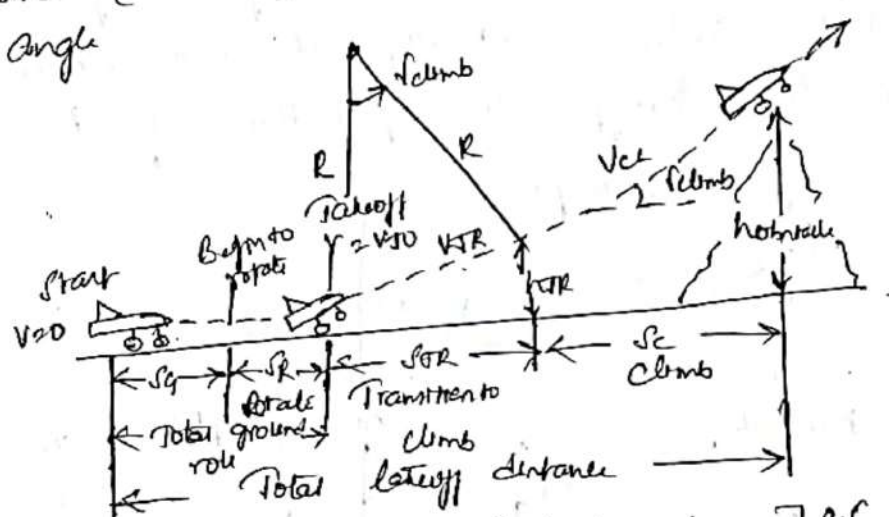
Subject Title: Flight Vehicle Design

Subject Code: 17AE52

Question Number	Solution	Marks Allocated
8.	<p><u>Free engine design</u> :</p> <ul style="list-style-type: none"> - The design procedure for the free-base engine is similar to the turbo engine design, with several expectations. - If the range is allowed to vary, the design problem is very simple. The required Thrust to weight ratio (T/W) is determined to provide all performance characteristics using the known data of the selected engine. - Take off weight is determined as the total engine takeoff thrust divided by the required takeoff thrust to weight ratio. $W_0 = \frac{N T_{\text{per engine}}}{(T/W)}$ <p>N - number of engines</p> $W_0 = W_{\text{crew}} + W_{\text{payload}}^{\text{free}} + W_{\text{payload}}^{\text{dropped}} + W_{\text{fuel}} + \left(\frac{W_{\text{ve}}}{W_0}\right) W_0$ $\frac{W_i}{W_{i-1}} = 1 - C(T/W)_d \quad C_T = C_T d$	<p>- 2 -</p> <p>- 2 -</p> <p>- 2 -</p> <p>- 2 -</p> <hr/> <p>10</p>

Subject Title: Flight Vehicle Design

Subject Code: 17AEE2

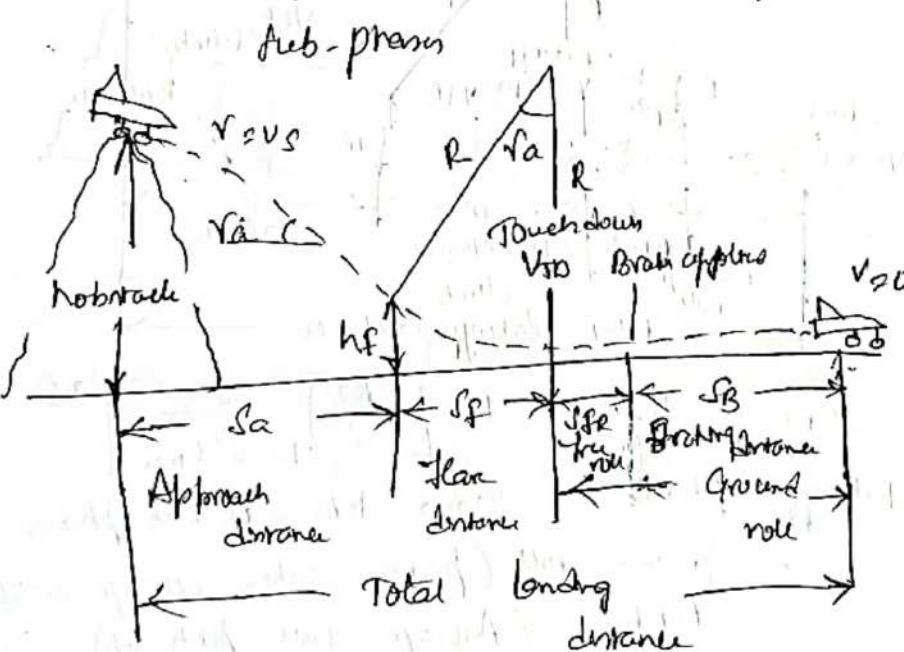
Question Number	Solution	Marks Allocated
9.	<p>* Figure illustrates the segments of the takeoff analysis. The ground roll includes two parts, the level ground-roll and ground roll during rotation to the angle of attack for lift off. After rotation the aircraft follows an approximately circular arc (parabola) until it reaches the climb angle.</p>  <p> $V_{TO} = 1.2 V_L \approx 1.2 \left[\left(\frac{W}{S} \right)_{TO} \frac{2}{\rho C_{Lmax}} \right]^{0.5}$ </p> <p>Takeoff phase is divided into 4 sub phases</p> <ul style="list-style-type: none"> - Ground roll (portion when aircraft accelerates) - Rotation (Aircraft will pitch up) - Transition - climb <p>Ground roll $S_g = \frac{1}{2g} \int_{v_i}^{v_f} \frac{dv}{K_T + K_A v^2}$</p> <p>$K_T = \left(\frac{T}{W} \right) - \mu$</p>	<p>- 2 -</p> <p>- 2 -</p> <p>- 2 -</p> <p>- 2 -</p>

et Code: 17AEE2
Marks Allocated



Subject Title: Flight vehicle Design

Subject Code: 17A68

Question Number	Solution	Marks Allocated
	<p>Transition: $n = 1.0 + \frac{V_{TR}^2}{Rg} = 1.2$</p> $R = \frac{V_{TR}^2}{g(n-1)} = \frac{V_{TR}^2}{0.2g} = 0.205 V_{TR}^2$ <p>Climb: $S_c = \frac{\text{hobtrac} - h_{TR}}{\tan \gamma_{climb}}$</p>	-2-
10.	<p>Figure illustrates the landing analysis which contains virtually the same elements as the takeoff. Explanation of the</p>  <p>Sub-phases</p> <p>Touchdown V_{TD} Brake applied</p> <p>Approach distance S_a Flare distance S_f Brake for roll S_{fr} Braking distance S_b Ground roll</p> <p>Total landing distance</p> $S_c = \frac{\text{hobtrac} - h_{TR}}{\tan \gamma_{climb}}$ $S_{fr \text{ climb}} = \frac{T-D}{W} \approx \frac{T}{W} - \frac{1}{4.0}$	-2- 10 -2- -2-

Question Number	Solution	Marks Allocated
	$S_T = R \sin \gamma \cos \alpha = R \left(\frac{T-D}{W} \right) \approx R \left(\frac{T}{W} - \frac{1}{L/D} \right)$ $h_{TR} = R (1 - \cos \gamma \cos \alpha)$ $S_G = \frac{1}{2g} \int_{v_i}^{v_f} \frac{dv}{k_T + k_A v^2} = \left(\frac{1}{2g k_A} \right) \ln \left(\frac{k_T + k_A v_f^2}{k_T + k_A v_i^2} \right)$	<p>-2-</p> <p>-0-</p>
	<p>6/7/22</p> <p>6/7/22</p> <p>(V Rajan)</p> <p>HOD. 6/7/22.</p> <p>Staff Incharge</p> <p>Return</p> <p>PROFESSOR & HEAD Department of Aeronautical Engineering S.J.C. Institute of Technology CHICKBALLAPUR-562101</p>	<p>10</p>

S J C INSTITUTE OF TECHNOLOGY
DEPARTMENT OF AERONAUTICAL ENGINEERING
FOR THE ACADEMIC YEAR 2020-21 (EVEN SEM)
SECOND INTERNAL ASSESSMENT - FLIGHT VEHICLE DESIGN - 17AE82

SL NO.	USN	NAME	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total (50)	Marks (30)
1	ISJ17AE002	ABHIJEET	10		10			10	10	10	10		49	30
2	ISJ17AE004	AKASH H A	9		10			9		9	10		47	28
3	ISJ17AE005	AKSHATA GUNDETI		10	10			9	10		9		48	29
4	ISJ17AE006	AMRUTHA R	9		8			10		9		10	46	28
5	ISJ17AE009	AVESODDIN SIDDIQUI FAHIMODDIN SIDDIQUI	9		10			9		9		5	42	26
6	ISJ17AE010	BASAVARAJU B N	9		10		10		10		9		48	29
7	ISJ17AE011	BHARATH B	9		9			8	9	9		10	45	27
8	ISJ17AE012	C H LOKESH	9		10			9	9	10			47	28
9	ISJ17AE013	CHANDANA N	10		10			9		10		10	49	30
10	ISJ17AE014	ERAGOWDA H G	9		10			9		10	9		47	28
11	ISJ17AE015	FIRDOSE BANU	9		9			10		10	9		47	28
12	ISJ17AE016	JAHANAVI R	9		9			10	10		10		48	29
13	ISJ17AE017	JASON JEEVAN C J	9		9			10	9		10		47	28
14	ISJ17AE018	KOTA SHREYAS PRAKASH	9		10		8			10	10		47	28
15	ISJ17AE019	KUMAR S	8		9			9	8		8	8	42	26
16	ISJ17AE020	LOCHANA B M		10	10			9		10	10		49	30
17	ISJ17AE021	MAGDUM ARITANT RAJGONDA	10		10			9	9		10		48	29
18	ISJ17AE022	MAHESH D N	10		9			10	10		10		49	30
19	ISJ17AE023	MALATHI S	10		10			9		10	10		49	30
20	ISJ17AE024	MANOJ C	9		10			10		9	9		47	28

21	ISJ17AE025	MEGHA MANNIKERI	10		10			10	10		10		50	30
22	ISJ17AE027	MOHAN D C	9		10			9	9			10	47	28
24	ISJ17AE028	NETHRA J	9		10			10		9		10	48	29
25	ISJ17AE029	NIHAL N	9		10			10		9	10		48	29
26	ISJ17AE030	NIKHIL M	9		10			10	9		10		48	29
27	ISJ17AE031	NISHAT MOMIN	10		10			10		9	10		49	30
28	ISJ17AE032	PAVAN KALYAN B V	9		10			9		8	10		46	28
29	ISJ17AE033	PRUTHVIJA P	9		10			9		9	10		47	28
30	ISJ17AE035	SACHINREDDY	9		10			9		9	10		47	28
31	ISJ17AE036	SANDEEP D	9		10			9		9	10		47	28
32	ISJ17AE037	SANDEEP N	9		9			9		9	10		46	28
33	ISJ17AE039	SATISH KUMAR H	8		8			8	9	8	9		42	26
34	ISJ17AE040	SIDDHARTH CHANDRA CHOUDHARY	9		8			8	8		9		42	26
35	ISJ17AE041	SRIDEVI M HERLE	9		9			10		10		10	48	29
36	ISJ17AE042	SUBHAM	9		9			10	10		10	10	48	29
37	ISJ17AE043	SUBHRA BERA	9		9			9	9		9	9	45	27
38	ISJ17AE044	SUHAS C	9		10			10		10	10		49	30
39	ISJ17AE048	NANDAN KUMAR .S	9		9			9		9	4		38	23
40	ISJ17AE049	GURUMALLESH		9	9			9	9		9		45	27
41	ISJ16AE002	ABHILASH M	9		8			8		10		10	43	26

Refame
Staff Incharge



Internal Test Question paper format- 201 Scheme
--

Name of the staff: Mrs. Deepa M S Date: 14.07.2021	Signature:
---	------------

Reviewer's Signature:	
-----------------------	--

NOTE: Only the following information's to be given to the students.

S.J.C. INSTITUTE OF TECHNOLOGY
DEPARTMENT OF AERONAUTICAL ENGINEERING

Test : III

Semester: VIII

Subject Name & Code: FLIGHT VEHICLE DESIGN – 17AE82

Date: 15.07.2021

Timings: 2:00 to 3:30 pm

Duration: 90 minutes

Max Marks: 50

Instructions**Answer FIVE questions by choosing one question from each**

Question Number	Question	Marks	COs	LEVEL
1	Describe longitudinal static stability and explain the main contributors of pitching moment with a neat sketch.	10	CO4	L3
OR				
2.	Describe lateral static stability and explain the main contributors of pitching moment with a neat sketch.	10	CO4	L3
3	Briefly describe the methods of Aileron, Elevator and Rudder sizing with relevant sketches and equations	10	CO4	L3
OR				
4	With the help of a Cooper-Harper scale explain the various flying qualities of an aircraft.	10	CO4	L3
5	Describe Landing gear arrangements and the subsystems involved in the design of landing gears	10	CO3	L3
OR				
6	With the help of relevant sketches explain the operation of Flight Control systems	10	CO3	L3
7.	With the help of a neat schematic diagram describe the cabin pressurization and air conditioning systems.	10	CO3	L3
OR				



8.	Briefly explain propulsion and fuel system integration in an aircraft.	10	CO3	L3
9.	Brief describe the following subsystems of aircraft i. Hydraulics system ii. Electrical system	10	CO3	L3
OR				
10	Brief describe the following subsystems of aircraft i. Pneumatic system ii. Auxiliary/Emergency Power	10	CO3	L3

Course Outcomes: At the end of this course, students are able to:

CO1	Estimate the overall weight and the effect of wing loading of an aircraft for different flight regimes (L5)
CO2	Design a structure of fuselage, suitable wing tail arrangement for a given aircraft (L5)
CO3	Predict the suitable propulsion system and sub-systems for a given aircraft (L4)
CO4	Calculate the stability characteristics and size of the control surfaces for an aircraft (L4)

DEPARTMENT: AERONAUTICAL ENGINEERING

Scheme & Solutions- TEST- I/II/III

Date: 14/7/2021

Semester: V

Subject Title: Flight Vehicle Design Subject Code: 17AE82

Question Number	Solution	
1.	<p>* Explanation of the longitudinal static stability with the following illustration of longitudinal moments and equations</p> $M_{cg} = L(x_{cg} - x_{acw}) + M_w + W_{wf} \delta_f + M_{fus} - L_h(x_{ach} - x_{cg}) - T_{z_t} + f_p(x_{cg} - x_p)$ $C_{m_{cg}} = C_L \left(\frac{x_{cg} - x_{acw}}{c} \right) + C_{m_w} + C_{m_{wf}} \delta_f + C_{m_{fus}} - \frac{q_h S_h}{q_{sw}} C_{L_h} \left(\frac{x_{ach} - x_{cg}}{c} \right) - \frac{T_{z_t}}{q_{sw} c} + \frac{f_p}{q_{sw}} (x_{cg} - x_p)$ $\eta_h = q_h / q$ $C_{m_{cg}} = C_L (\bar{x}_{cg} - \bar{x}_{acw}) + C_{m_w} + C_{m_{wf}} \delta_f + C_{m_{fus}} - \eta_h \frac{S_h}{S_w} C_{L_h} (\bar{x}_{ach} - \bar{x}_{cg}) - \frac{T}{q_{sw}} \bar{z}_t + \frac{f_p}{q_{sw}} (\bar{x}_{cg} - \bar{x}_p)$	<p>-4-</p> <p>-2-</p> <p>-2-</p> <p>-2-</p> <hr/> <p>10</p>
2	<p>* Explanation of the lateral static stability with the following illustration of lateral moments & equations</p> $N = N_{wing} + N_{wda} \delta_a + N_{fus} + F_v (x_{acw} - x_{cg}) - T_{y_p} - D_{y_p} - f_p (x_{cg} - x_p)$	<p>-4-</p>



Subject Title: **Flight Vehicle Design**

Subject Code: **15151**

Question Number	Solution
	$L = L_{wing} + L_{wada} - F_D(z)$ $F_D = \rho v^2 C_{Dcr} \frac{\partial b_i}{\partial \beta} \beta$ <p>Yaw:</p> $C_n = \frac{N}{q S b} = C_{n\beta} \beta + C_{n\dot{\beta}} \dot{\beta} + C_{n\ddot{\beta}} \ddot{\beta}$ $C_{n\beta} = \frac{L_{wada}}{q S b} - \frac{F_D}{q S b} = \frac{L_{wada}}{q S b} - \frac{\rho}{2q} (\bar{V}_{eq} - \bar{V}_e)$ $C_{n\dot{\beta}} = C_{Dcr} \frac{\partial b_i}{\partial \beta} \eta_r \frac{S_r}{S_e} (\bar{V}_{eq} - \bar{V}_e)$ <p>Roll:</p> $C_l = \frac{L}{q S b} = C_{l\beta} \beta + C_{l\dot{\beta}} \dot{\beta} + C_{l\ddot{\beta}} \ddot{\beta}$ $C_{l\beta} = -C_{Dcr} \frac{\partial b_i}{\partial \beta} \eta_r \frac{S_r}{S_e} \bar{V}_e$
3.	<p>* Explanation of the process of control surface being based on the dynamic analysis of control effectiveness, including structural bending in control system.</p> <p>* <u>Adverse rolling</u>: Explanation of adverse rolling in span. The adverse rolling entered from about 50% to about 90% of the span.</p>

-2-

-2-

-2-

10

-1-

Subject Title: Flugzeug Vehicle Design

Subject Code: 17AE82

Question Number	Solution	Marks Allocated
		-2-
	<p style="text-align: center;">$C_{L\beta} = -C_{L\beta}$</p>	-1-
	<p style="text-align: center;">Rudder design: $C_n = 0 = \frac{-(T + D_e)}{q S_w b} + C_{n\beta} \beta + C_{nr} r$</p> <p style="text-align: center;">$C_{nr} = \frac{dC_n}{dr}$ $D_e = C_d q S_e$</p> <p style="text-align: center;">$C_n = 0 = C_{n\beta} \beta + C_{nr} r$</p> <p style="text-align: center;">$C_{nr} \approx 0.9 (C_{L\beta})_{\beta=1} \bar{V}_{rs} \frac{dC_{L\beta}}{d\beta}$</p> <p style="text-align: center;">$\frac{dC_{L\beta}}{d\beta} = \frac{-C_{L\beta}}{C_{L\beta}} \cdot \frac{1}{\beta} k'$</p>	<p style="text-align: center;">-2-</p> <p style="text-align: center;">-1-</p> <p style="text-align: center;">-2-</p> <hr/> <p style="text-align: center;">10.</p>



Subject Title: Flight Vehicle Design

Subject Code: MAE82

Question Number	Solution	Marks Allocated
4.	<p>* Explanation of various flying qualities along with the list of qualities required</p> <p>Level 1 - flying qualities clearly adequate for the mission flight plan</p> <p>Level 2 - adequate to accomplish the mission flight plan, but some increase in pilot workload or degradation in mission effectiveness</p> <p>Level 3 - flying qualities such that the airplane can be controlled safely, but pilot workload is excessive or mission effectiveness is inadequate</p> <p>* Explanation of various classes of aircraft such as</p> <p>Class I - Small, light airplanes, primary trainer & light observation craft</p> <p>Class II - medium weight, low to medium maneuverability, heavy utility</p> <p>Class III - large, heavy, low to medium</p> <p>Class IV - High maneuverability, fighters</p> <p>* Cooper - Harper scale</p>	<p>- 1</p> <p>- 1</p> <p>- 1</p> <p>- 1</p> <p>- 2</p> <p>- 3</p> <hr/> <p>10</p>

Subject Title: Light Vehicle Design

Subject Code: 17AE82

Question Number	Solution	Marks Allocated
5.	<p>* List of various types of landing gear such as Single main, tail dragger, Quadicycle, Bicycle & tricycle & multi bogey</p> <p>* Sketches of all the types of landing gear</p> <p>* Explanation of atleast three types of landing gear arrangement</p>	<p>-2-</p> <p>-2-</p> <p>2x3 = 6.</p> <hr/> <p>10</p>
6.	<p>* Flight control system (FCS) consists of 4 basic elements - Pilot/Guest pilot, - Control system, - Actuator, - Control system</p> <p>* Schematic diagram of a flight control system</p> <p>* Conventional winged edge flying control surfaces are divided into</p> <p>- Primary group - Aileron, elevator, Rudder, - Secondary group - Trim tabs, Spring tab</p> <p>- Auxiliary group - wing flaps, Spoilers, Speed brakes, etc.</p>	<p>-2-</p> <p>-2-</p> <p>-2-</p> <p>-2-</p> <hr/> <p>10.</p>



Subject

Subject Title: Flight vehicle Design

Subject Code: 17AE82

Question Number	Solution	Marks Allocated
7.	<p>* <u>Cabin pressurization and Air Conditioning</u></p> <ul style="list-style-type: none"> - At cruise altitude temperature drops to -50°C and below, and the pressure and density reduce to less than one fifth and one-fourth of sea level values - Above 14000 ft altitude, the aircraft interior environment must be controlled for crew and passenger comfort as well as equipment protection. - Aircraft environmental control system (ECS) consists of cabin pressurization and air conditioning. - The cabin interior pressure maintained at sea level conditions is ideal but expensive. - Explanation of the process of cabin pressurization and air conditioning in aircraft - Sketch of air conditioning system and cabin airflow etc. 	<p>-2-</p> <p>-2-</p> <p>-2-</p> <p>-2-</p>
		10.

17AE82

Subject Title: Flight Vehicle Design

Subject Code: 17AE82

Question Number	Solution	Marks Allocated
8.	<p>* Propulsion and fuel integration in an aircraft.</p> <p>- A typical piston engine fuel control system consists of</p> <ul style="list-style-type: none"> - Ignition and starting system - Throttle to control fuel flow - Fuel storage tank & fuel flow management <p>* Explanation and sketch of a piston engine fuel system</p> <p>* A typical turbofan engine fuel control system consists of</p> <ul style="list-style-type: none"> - Ignition and starting system - Throttle to control fuel flow - Fuel storage & flow management - Engine cooling system - Engine anti-icing system - EOH system - Fire sensing & protection system - Fault detection system - Instrumentation & sensors <p>* Sketch of a Turbofan engine fuel</p>	<p>- 2 -</p> <p>- 4 -</p> <p>- 2 -</p> <p>- 2 -</p> <hr/> <p>10.</p>



Subject Title: Flight Vehicle Design

Question Number	Solution	Marks Allocated
9.	<p>a) <u>Hydraulic system</u>: Hydraulic system includes fluid reservoir, electricity driven pumps, hydraulic lines, valves & pilot valves at the flight deck</p> <ul style="list-style-type: none"> - Hydraulic driven actuators are interposed at a higher pressure level to activate the following uses: <ul style="list-style-type: none"> - Aircraft Control system - Engine thrust reversers - Undercarriage deployment & retraction - Brake application <p>* Sketch of a hydraulic system with all the parts labelled</p> <p>b) <u>Electrical system</u>: All aircraft must have a form of electrical supply to power the aircraft systems. The supply of electricity is provided by a combination of generators and batteries. Most modern aircraft require both AC & DC supplies.</p> <ul style="list-style-type: none"> - The following systems are associated with electrical power. <ul style="list-style-type: none"> - Engine starting & operation. - Lighting - Flight deck instrumentation - Communication & navigation - Auxiliary power unit 	<p>-1-</p> <p>-2-</p> <p>-2-</p> <p>-2-</p> <p>-2-</p> <p>-1-</p>
		10.

Subject Code: 17AE82
 Marks Allocated

Page 9 of 10
 Subject Title: Flight Vehicle Design

Subject Code: 17AE82

Question Number	Solution	Marks Allocated
10	<p>i) <u>Pneumatic systems</u></p> <ul style="list-style-type: none"> - The pneumatic system provides compressed air for pressurization, environmental control, anti-icing, & in some cases engine starting. - The pneumatic system uses pressurized air from the engine compressor. This compressed air is cooled through a heat exchanger using outside air. The cooled compressed air is then used for cockpit pressurization and avionics cooling. - For anti-icing the compressed air goes uncooled through ducts to the wing leading edge, inlet cowl, & windshield. <p>ii) <u>Auxiliary / Emergency power</u></p> <ul style="list-style-type: none"> - Large or high-speed aircraft are completely dependent upon the hydraulic system for flight control. If the hydraulic pump stop producing pressure for any reason, the aircraft will be uncontrollable. - If the pumps are driven off the engine an engine failure will cause an immediate loss of control. Thus some form of emergency hydraulic power is required. 	<p>-2-</p> <p>-2-</p> <p>-1-</p> <p>-3-</p> <p>-2-</p> <p>5</p>

Staff Incharge

Reviewer

(V Ravi Kumar)
 HOD (AE) 4/8/24

||JAI SRI GURUDEV||
 S.J.C. INSTITUTE OF TECHNOLOGY
 DEPARTMENT OF AERONAUTICAL ENGG.
 For the Academic Year 2020-2021 (Even Semester)

THIRD INTERNAL ASSESSMENT - FLIGHT VEHICLE DESIGN - 17AE82

SL NO	USN	NAME	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total (50)	Marks (30)
1	1SJ17AE002	ABHIJEET	9			10	10			9	10		48	29
2	1SJ17AE004	AKASH H A	10		9		10		10		10		49	30
3	1SJ17AE005	AKSHATA GUNDETI		10		10	10		9		10		49	30
4	1SJ17AE006	AMRUTHA R	9			9		10		10		10	48	29
5	1SJ17AE009	AVESODDIN SIDDIQUI FAHIMODDIN SIDDIQUI	9			10	9			10	10		48	29
6	1SJ17AE010	BASAVARAJU B N		10		6	9			9		8	42	26
7	1SJ17AE011	BHARATH B	10		10			8	10		10		48	29
8	1SJ17AE012	C H LOKESH	10			9	8		9		10		46	28
9	1SJ17AE013	CHANDANA N	10			10		10		10		9	49	30
10	1SJ17AE014	ERAGOWDA H G	10		10		10			9	10		49	30
11	1SJ17AE015	FIRDOSE BANU	10			10	9		9			9	47	28
12	1SJ17AE016	JAHANAVI R	10			10		9		10		10	49	30
13	1SJ17AE017	JASON JEEVAN C J		9		10	10		9	9		10	48	29
14	1SJ17AE018	KOTA SHREYAS PRAKASH		10		9	6			9	10		44	27
15	1SJ17AE019	KUMAR S	9			8		7		8		6	38	23
16	1SJ17AE020	LOCHANA B M	10			10		10		9		9	48	29
17	1SJ17AE021	MAGDUM ARIHANT RAJGONDA	8			8	9			7		9	41	25
18	1SJ17AE022	MAHESH D N	10			10	10		10		9		49	30

	USN	NAME	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total (50)	Marks (30)
19	1SJ17AE023	MALATHI S	10			10	10		9			10	49	30
20	1SJ17AE024	MANOJ C	10		8		10			9	10		47	28
21	1SJ17AE025	MEGHA MANNIKERI	10			10		10	10		10		50	30
22	1SJ17AE027	MOHAN D C	10			8		8		9		10	47	28
23	1SJ17AE028	NETHRA J	10			10	9			10	10		49	29
24	1SJ17AE029	NIHAL N	9			9		10	9			10	47	28
25	1SJ17AE030	NIKHIL M	9			10	10			10		10	49	29
26	1SJ17AE031	NISHAT MOMIN	10			10		9	10		10	10	49	29
27	1SJ17AE032	PAVAN KALYAN B V	10			8	7		10			9	44	27
28	1SJ17AE033	PRUTHVIJA P	10			10		9		10		10	49	29
29	1SJ17AE035	SACHINREDDY	10			10		10		9		10	49	29
30	1SJ17AE036	SANDEEP D		10		8	10		9	9	10	10	47	28
31	1SJ17AE037	SANDEEP N	9			10		10		9		9	47	28
32	1SJ17AE039	SATISH KUMAR H	6			8	6			7		6	33	20
33	1SJ17AE040	SIDDHARTH CHANDRA CHOUHARY	9			10				9		7	35	21
34	1SJ17AE041	SRIDEVI M HERLE	10			8		9		10	10		47	28
35	1SJ17AE042	SUBHAM	8			0		10	10		9		37	22
36	1SJ17AE043	SUBHRA BERA	7			10	6			7		8	38	23
37	1SJ17AE044	SUHAS C	10			9		10		9		8	46	28
38	1SJ17AE048	NANDAN KUMAR .S	9			10		8		8		10	46	28
39	1SJ17AE049	GURUMALLESH												AB
40	1SJ16AE002	ABHILASH M	10			8		8		9	10		45	27

Ref: 18/7/201
Staff Incharge


PROFESSOR & HEAD
Department of Aeronautical Engineering
S.J.C. Institute of Technology
S.No. 101

Branch : AE

Semester : 8

SI NO.	USN	15AE82
1	1SJ16AE026	14
2	1SJ16AE046	13

Verified & found correct
Return
28/7/21


(V. Rajan)
28/7/21

Draft, As Entered in VTU CIE Portal on 2021-07-28 11:53:33

PROFESSOR & HEAD
Department of Aeronautical Engineering
S.J.C. Institute of Technology
CHICKBALLAPUR-552101

Branch : AE

Semester : B

Sl NO.	USN	17AE82
1	1SJ16AE002	36
2	1SJ17AE002	40
3	1SJ17AE004	39
4	1SJ17AE005	39
5	1SJ17AE006	37
6	1SJ17AE009	37
7	1SJ17AE010	37
8	1SJ17AE011	38
9	1SJ17AE012	39
10	1SJ17AE013	40
11	1SJ17AE014	39
12	1SJ17AE015	36
13	1SJ17AE016	39
14	1SJ17AE017	39
15	1SJ17AE018	37
16	1SJ17AE019	33
17	1SJ17AE020	40
18	1SJ17AE021	37
19	1SJ17AE022	40
20	1SJ17AE023	40
21	1SJ17AE024	37
22	1SJ17AE025	40
23	1SJ17AE027	36
24	1SJ17AE028	39
25	1SJ17AE029	39
26	1SJ17AE030	39
27	1SJ17AE031	39
28	1SJ17AE032	38
29	1SJ17AE033	38
30	1SJ17AE035	37
31	1SJ17AE036	35
32	1SJ17AE037	38
33	1SJ17AE039	33
34	1SJ17AE040	34
35	1SJ17AE041	37
36	1SJ17AE042	35

SI NO.	USN	17AES2
37	1SJ17AE043	36
38	1SJ17AE044	39
39	1SJ17AE048	36
40	1SJ17AE049	25

Verified & found OK
 Ref: 28/7/2021

(V Rajin)
 28/7/21

Draft, As Entered in VTU CIE Portal on 2021-07-28 11:59:03

PROFESSOR & HEAD
 Department of Aeronautical Engineering
 S.J.C. Institute of Technology
 CHICKBALLAPUR-562101

Jai Sri Gurudev
 Department of AERONAUTICAL ENGINEERING
 Subject : FLIGHT VEHICLE DESIGN
 Subject code:17AE82

CO1	Estimate the overall weight and the effect of wing loading of an aircraft for different flight regimes (L5)
CO2	Design a structure of fuselage, suitable wing tail arrangement for a given aircraft (L5)
CO3	Predict the suitable propulsion system and sub-systems for a given aircraft (L4)
CO4	Calculate the stability characteristics and size of the control surfaces for an aircraft (L4)
CO5	

CO-PO & CO-PSO MAPPING MATRIX														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	-	-	-	1	1	2	1	1	3	2
CO2	3	3	3	3	-	-	-	1	1	2	1	1	3	2
CO3	3	3	3	3	-	-	-	1	1	2	1	1	3	2
CO4	3	3	3	3	-	-	-	1	1	2	1	1	3	2
AVG	3	3	3	2.75	-	-	-	1	1	2.00	1.00	1.00	3	2

Overall CO Attainment LEVEL.	
CO1	2.96
CO2	2.95
CO3	2.96
CO4	2.96

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2.96	2.96	2.96	1.97	-	-	-	0.99	0.99	1.97	0.99	0.99	2.96	1.97
CO2	2.95	2.95	2.95	2.95	-	-	-	0.98	0.98	1.97	0.98	0.98	2.95	1.97
CO3	2.96	2.96	2.96	2.96	-	-	-	0.99	0.99	1.98	0.99	0.99	2.96	1.98
CO4	2.96	2.96	2.96	2.96	-	-	-	0.99	0.99	1.97	0.99	0.99	2.96	1.97
Average	2.96	2.96	2.96	2.71	-	-	-	0.99	0.99	1.97	0.99	0.99	2.96	1.97

Prof. Dr. Jayaram
 Sreyal Indrag

Prof. Dr. Jayaram
PROFESSOR & HEAD
 Department of Aeronautical Engineering
 S.J.C. Institute of Technology
 CHIKKALAPUR, 591301

Program Outcomes

PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering science.
PO3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the environment, and the manufacturability, and cost.
PO4	Conduct investigations of complex problems: Use research-based knowledge and research methods (including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions).
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and ethical issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for, sustainable development.
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and team work: Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.
PO10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documents, make presentations, and give and receive clear instructions.
PO11	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and activities.
PO12	Lifelong learning: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

PS01 Apply knowledge acquired from the programme to develop, maintain, service and market aerospace products and endeavor to improve solutions for Aeronautical problems in their working environment

PS02 Continue to learn and adopt the regulations/specifications for design, manufacturing and testing of aircraft and its components with special emphasis on adherence to strict quality control and safety of crew, material and machine.

Course Outcomes:
At the end of the course students should be able to

CO1	Estimate the overall weight and the effect of wing loading of an aircraft for different flight regimes (L5)
CO2	Design a structure of fuselage, suitable wing tail arrangement for a given aircraft (L5)
CO3	Predict the suitable propulsion system and sub-systems for a given aircraft (L4)
CO4	Calculate the stability characteristics and size of the control surfaces for an aircraft (L4)

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	3	3	3	2	-	-	-	1	1	2	1	1	3	2
CO2	3	3	3	3	-	-	-	1	1	2	1	1	3	2
CO3	3	3	3	3	-	-	-	1	1	2	1	1	3	2
CO4	3	3	3	3	-	-	-	1	1	2	1	1	3	2
AVG	3	3	3	3	-	-	-	1	1	2	1	1	3	2

1: Slightly 2: Moderately 3: Substantially




PROFESSOR & HEAD
Department of Aeronautical Engineering
S.A.D. Institute of Technology
CHICAGOILAPUR, KARNATAKA

Timestamp	NAME OF THE STUDENT	USN	How well you have been able to Estimate the overall weight and the effect of wing loading of an aircraft for different flight regimes	How well you have been able to Design a structure of fuselage, suitable wing tail arrangement for a given aircraft	How well you have been able to Predict the suitable propulsion system and sub systems for a given aircraft	How well you have been able to Calculate the stability characteristics and size of the control surfaces for an aircraft
8/4/2021 13:17	Avesoddin siddiqui	1SJ17AE009	4	4	4	4
8/4/2021 13:17	Sachinreddy	1SJ17AE035	1	2	2	2
8/4/2021 13:17	Bharath B	1SJ17AE011	5	5	5	5
8/4/2021 13:18	Sachinreddy	1SJ17AE035	5	5	4	5
8/4/2021 13:18	Sridevi M Herle	1SJ17AE041	5	5	5	5
8/4/2021 13:21	Pavan kalyan B V	1sj17ae032	5	5	5	5
8/4/2021 13:38	Nihal N	1SJ17AE029	5	5	5	5
8/4/2021 13:49	Jason Jeevan C J	1SJ17AE017	5	5	5	5
8/4/2021 13:58	Firdose Banu	1SJ17AE015	5	5	4	4
8/4/2021 14:09	Satish kumar H	1sj17ae039	4	3	4	4
8/4/2021 14:10	CH Lokesh	1SJ17AE012	5	5	5	5
8/4/2021 16:50	Eragowda HG	1SJ17AE014	4	4	4	4
8/4/2021 17:13	Lochana B M	1SJ17AE020	3	3	3	3
8/4/2021 17:32	sandeep d	1sj17ae036	5	5	5	5
8/4/2021 18:04	Akshata Gundeti	1SJ17AE005	3	3	4	3
8/4/2021 18:17	Pruthvija P	1SJ17AE033	3	3	5	4
8/4/2021 18:24	K Shreyas prakash	1sj17ae018	4	4	5	5
8/4/2021 18:53	Mahesh.D.N	1SJ17AE022	4	4	4	4
8/4/2021 19:45	Manoj c	1sj17ae024	5	5	5	5
8/4/2021 20:15	SUBHRA BERA	1SJ17AE043	5	5	5	5
8/4/2021 20:43	Abhijeet	1SJ17AE002	4	3	4	3
8/4/2021 22:38	Malathi S	1SJ17AE023	4	3	4	4
8/4/2021 22:48	Gurumallesh k m	1SJ17AE049	4	3	3	3
8/5/2021 7:49	Kumar S	1SJ17AE019	4	4	4	4
8/5/2021 7:50	Kumar S	1SJ17AE019	4	4	4	4
8/5/2021 7:50	Sandeep N	1S717AE037	5	5	5	5
8/5/2021 9:18	NIKHIL M	1SJ17AE030	5	5	5	5
8/6/2021 11:12	Suhas C	1SJ17AE044	4	4	5	5
8/6/2021 17:18	Basavaraju B N	1SJ17AE010	5	5	5	5
		Excellent - 5	14	14	15	15
		Very Good - 4	11	7	11	9
		Good - 3	3	7	2	4
		Satisfactory - 2	0	1	1	1
		Unsatisfactory -	1	0	0	0
		No. of students responded	29	29	29	29
		TOTAL	124	121	127	125
		co attainment indirect(on a scale of 5)	4.28	4.17	4.38	4.31
		co attainment indirect(on a scale of 3)	2.57	2.50	2.63	2.59

Steph Incharge

PROFESSOR & HEAD
Department of Aeronautical Engineering
S.J.C. Institute of Technology
CHICKBALLAPUR-562101

SJCIT NBA Document NBA-AED-CR 3.1.1

Department	ATKINSVILLE ENGINEERING
Program	ME (2017-20)
Course	MECH 390 (2017-20)
SEMESTER	FIFTH

Sl. No.	ENR	Name	Mid 1										Mid 2										Mid 3										Final Exam																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
			Q1/Q2	Q3/Q4	Q5/Q6	Q7/Q8	Q9/Q10	Q11/Q12	Q13/Q14	Q15/Q16	Q17/Q18	Q19/Q20	Q21/Q22	Q23/Q24	Q25/Q26	Q27/Q28	Q29/Q30	Q31/Q32	Q33/Q34	Q35/Q36	Q37/Q38	Q39/Q40	Q41/Q42	Q43/Q44	Q45/Q46	Q47/Q48	Q49/Q50	Q51/Q52	Q53/Q54	Q55/Q56	Q57/Q58	Q59/Q60	Q61/Q62	Q63/Q64	Q65/Q66	Q67/Q68	Q69/Q70	Q71/Q72	Q73/Q74	Q75/Q76	Q77/Q78	Q79/Q80	Q81/Q82	Q83/Q84	Q85/Q86	Q87/Q88	Q89/Q90	Q91/Q92	Q93/Q94	Q95/Q96	Q97/Q98	Q99/Q100	Q101/Q102	Q103/Q104	Q105/Q106	Q107/Q108	Q109/Q110	Q111/Q112	Q113/Q114	Q115/Q116	Q117/Q118	Q119/Q120	Q121/Q122	Q123/Q124	Q125/Q126	Q127/Q128	Q129/Q130	Q131/Q132	Q133/Q134	Q135/Q136	Q137/Q138	Q139/Q140	Q141/Q142	Q143/Q144	Q145/Q146	Q147/Q148	Q149/Q150	Q151/Q152	Q153/Q154	Q155/Q156	Q157/Q158	Q159/Q160	Q161/Q162	Q163/Q164	Q165/Q166	Q167/Q168	Q169/Q170	Q171/Q172	Q173/Q174	Q175/Q176	Q177/Q178	Q179/Q180	Q181/Q182	Q183/Q184	Q185/Q186	Q187/Q188	Q189/Q190	Q191/Q192	Q193/Q194	Q195/Q196	Q197/Q198	Q199/Q200	Q201/Q202	Q203/Q204	Q205/Q206	Q207/Q208	Q209/Q210	Q211/Q212	Q213/Q214	Q215/Q216	Q217/Q218	Q219/Q220	Q221/Q222	Q223/Q224	Q225/Q226	Q227/Q228	Q229/Q230	Q231/Q232	Q233/Q234	Q235/Q236	Q237/Q238	Q239/Q240	Q241/Q242	Q243/Q244	Q245/Q246	Q247/Q248	Q249/Q250	Q251/Q252	Q253/Q254	Q255/Q256	Q257/Q258	Q259/Q260	Q261/Q262	Q263/Q264	Q265/Q266	Q267/Q268	Q269/Q270	Q271/Q272	Q273/Q274	Q275/Q276	Q277/Q278	Q279/Q280	Q281/Q282	Q283/Q284	Q285/Q286	Q287/Q288	Q289/Q290	Q291/Q292	Q293/Q294	Q295/Q296	Q297/Q298	Q299/Q300	Q301/Q302	Q303/Q304	Q305/Q306	Q307/Q308	Q309/Q310	Q311/Q312	Q313/Q314	Q315/Q316	Q317/Q318	Q319/Q320	Q321/Q322	Q323/Q324	Q325/Q326	Q327/Q328	Q329/Q330	Q331/Q332	Q333/Q334	Q335/Q336	Q337/Q338	Q339/Q340	Q341/Q342	Q343/Q344	Q345/Q346	Q347/Q348	Q349/Q350	Q351/Q352	Q353/Q354	Q355/Q356	Q357/Q358	Q359/Q360	Q361/Q362	Q363/Q364	Q365/Q366	Q367/Q368	Q369/Q370	Q371/Q372	Q373/Q374	Q375/Q376	Q377/Q378	Q379/Q380	Q381/Q382	Q383/Q384	Q385/Q386	Q387/Q388	Q389/Q390	Q391/Q392	Q393/Q394	Q395/Q396	Q397/Q398	Q399/Q400	Q401/Q402	Q403/Q404	Q405/Q406	Q407/Q408	Q409/Q410	Q411/Q412	Q413/Q414	Q415/Q416	Q417/Q418	Q419/Q420	Q421/Q422	Q423/Q424	Q425/Q426	Q427/Q428	Q429/Q430	Q431/Q432	Q433/Q434	Q435/Q436	Q437/Q438	Q439/Q440	Q441/Q442	Q443/Q444	Q445/Q446	Q447/Q448	Q449/Q450	Q451/Q452	Q453/Q454	Q455/Q456	Q457/Q458	Q459/Q460	Q461/Q462	Q463/Q464	Q465/Q466	Q467/Q468	Q469/Q470	Q471/Q472	Q473/Q474	Q475/Q476	Q477/Q478	Q479/Q480	Q481/Q482	Q483/Q484	Q485/Q486	Q487/Q488	Q489/Q490	Q491/Q492	Q493/Q494	Q495/Q496	Q497/Q498	Q499/Q500	Q501/Q502	Q503/Q504	Q505/Q506	Q507/Q508	Q509/Q510	Q511/Q512	Q513/Q514	Q515/Q516	Q517/Q518	Q519/Q520	Q521/Q522	Q523/Q524	Q525/Q526	Q527/Q528	Q529/Q530	Q531/Q532	Q533/Q534	Q535/Q536	Q537/Q538	Q539/Q540	Q541/Q542	Q543/Q544	Q545/Q546	Q547/Q548	Q549/Q550	Q551/Q552	Q553/Q554	Q555/Q556	Q557/Q558	Q559/Q560	Q561/Q562	Q563/Q564	Q565/Q566	Q567/Q568	Q569/Q570	Q571/Q572	Q573/Q574	Q575/Q576	Q577/Q578	Q579/Q580	Q581/Q582	Q583/Q584	Q585/Q586	Q587/Q588	Q589/Q590	Q591/Q592	Q593/Q594	Q595/Q596	Q597/Q598	Q599/Q600	Q601/Q602	Q603/Q604	Q605/Q606	Q607/Q608	Q609/Q610	Q611/Q612	Q613/Q614	Q615/Q616	Q617/Q618	Q619/Q620	Q621/Q622	Q623/Q624	Q625/Q626	Q627/Q628	Q629/Q630	Q631/Q632	Q633/Q634	Q635/Q636	Q637/Q638	Q639/Q640	Q641/Q642	Q643/Q644	Q645/Q646	Q647/Q648	Q649/Q650	Q651/Q652	Q653/Q654	Q655/Q656	Q657/Q658	Q659/Q660	Q661/Q662	Q663/Q664	Q665/Q666	Q667/Q668	Q669/Q670	Q671/Q672	Q673/Q674	Q675/Q676	Q677/Q678	Q679/Q680	Q681/Q682	Q683/Q684	Q685/Q686	Q687/Q688	Q689/Q690	Q691/Q692	Q693/Q694	Q695/Q696	Q697/Q698	Q699/Q700	Q701/Q702	Q703/Q704	Q705/Q706	Q707/Q708	Q709/Q710	Q711/Q712	Q713/Q714	Q715/Q716	Q717/Q718	Q719/Q720	Q721/Q722	Q723/Q724	Q725/Q726	Q727/Q728	Q729/Q730	Q731/Q732	Q733/Q734	Q735/Q736	Q737/Q738	Q739/Q740	Q741/Q742	Q743/Q744	Q745/Q746	Q747/Q748	Q749/Q750	Q751/Q752	Q753/Q754	Q755/Q756	Q757/Q758	Q759/Q760	Q761/Q762	Q763/Q764	Q765/Q766	Q767/Q768	Q769/Q770	Q771/Q772	Q773/Q774	Q775/Q776	Q777/Q778	Q779/Q780	Q781/Q782	Q783/Q784	Q785/Q786	Q787/Q788	Q789/Q790	Q791/Q792	Q793/Q794	Q795/Q796	Q797/Q798	Q799/Q800	Q801/Q802	Q803/Q804	Q805/Q806	Q807/Q808	Q809/Q810	Q811/Q812	Q813/Q814	Q815/Q816	Q817/Q818	Q819/Q820	Q821/Q822	Q823/Q824	Q825/Q826	Q827/Q828	Q829/Q830	Q831/Q832	Q833/Q834	Q835/Q836	Q837/Q838	Q839/Q840	Q841/Q842	Q843/Q844	Q845/Q846	Q847/Q848	Q849/Q850	Q851/Q852	Q853/Q854	Q855/Q856	Q857/Q858	Q859/Q860	Q861/Q862	Q863/Q864	Q865/Q866	Q867/Q868	Q869/Q870	Q871/Q872	Q873/Q874	Q875/Q876	Q877/Q878	Q879/Q880	Q881/Q882	Q883/Q884	Q885/Q886	Q887/Q888	Q889/Q890	Q891/Q892	Q893/Q894	Q895/Q896	Q897/Q898	Q899/Q900	Q901/Q902	Q903/Q904	Q905/Q906	Q907/Q908	Q909/Q910	Q911/Q912	Q913/Q914	Q915/Q916	Q917/Q918	Q919/Q920	Q921/Q922	Q923/Q924	Q925/Q926	Q927/Q928	Q929/Q930	Q931/Q932	Q933/Q934	Q935/Q936	Q937/Q938	Q939/Q940	Q941/Q942	Q943/Q944	Q945/Q946	Q947/Q948	Q949/Q950	Q951/Q952	Q953/Q954	Q955/Q956	Q957/Q958	Q959/Q960	Q961/Q962	Q963/Q964	Q965/Q966	Q967/Q968	Q969/Q970	Q971/Q972	Q973/Q974	Q975/Q976	Q977/Q978	Q979/Q980	Q981/Q982	Q983/Q984	Q985/Q986	Q987/Q988	Q989/Q990	Q991/Q992	Q993/Q994	Q995/Q996	Q997/Q998	Q999/Q1000	Q1001/Q1002	Q1003/Q1004	Q1005/Q1006	Q1007/Q1008	Q1009/Q1010	Q1011/Q1012	Q1013/Q1014	Q1015/Q1016	Q1017/Q1018	Q1019/Q1020	Q1021/Q1022	Q1023/Q1024	Q1025/Q1026	Q1027/Q1028	Q1029/Q1030	Q1031/Q1032	Q1033/Q1034	Q1035/Q1036	Q1037/Q1038	Q1039/Q1040	Q1041/Q1042	Q1043/Q1044	Q1045/Q1046	Q1047/Q1048	Q1049/Q1050	Q1051/Q1052	Q1053/Q1054	Q1055/Q1056	Q1057/Q1058	Q1059/Q1060	Q1061/Q1062	Q1063/Q1064	Q1065/Q1066	Q1067/Q1068	Q1069/Q1070	Q1071/Q1072	Q1073/Q1074	Q1075/Q1076	Q1077/Q1078	Q1079/Q1080	Q1081/Q1082	Q1083/Q1084	Q1085/Q1086	Q1087/Q1088	Q1089/Q1090	Q1091/Q1092	Q1093/Q1094	Q1095/Q1096	Q1097/Q1098	Q1099/Q1100	Q1101/Q1102	Q1103/Q1104	Q1105/Q1106	Q1107/Q1108	Q1109/Q1110	Q1111/Q1112	Q1113/Q1114	Q1115/Q1116	Q1117/Q1118	Q1119/Q1120	Q1121/Q1122	Q1123/Q1124	Q1125/Q1126	Q1127/Q1128	Q1129/Q1130	Q1131/Q1132	Q1133/Q1134	Q1135/Q1136	Q1137/Q1138	Q1139/Q1140	Q1141/Q1142	Q1143/Q1144	Q1145/Q1146	Q1147/Q1148	Q1149/Q1150	Q1151/Q1152	Q1153/Q1154	Q1155/Q1156	Q1157/Q1158	Q1159/Q1160	Q1161/Q1162	Q1163/Q1164	Q1165/Q1166	Q1167/Q1168	Q1169/Q1170	Q1171/Q1172	Q1173/Q1174	Q1175/Q1176	Q1177/Q1178	Q1179/Q1180	Q1181/Q1182	Q1183/Q1184	Q1185/Q1186	Q1187/Q1188	Q1189/Q1190	Q1191/Q1192	Q1193/Q1194	Q1195/Q1196	Q1197/Q1198	Q1199/Q1200	Q1201/Q1202	Q1203/Q1204	Q1205/Q1206	Q1207/Q1208	Q1209/Q1210	Q1211/Q1212	Q1213/Q1214	Q1215/Q1216	Q1217/Q1218	Q1219/Q1220	Q1221/Q1222	Q1223/Q1224	Q1225/Q1226	Q1227/Q1228	Q1229/Q1230	Q1231/Q1232	Q1233/Q1234	Q1235/Q1236	Q1237/Q1238	Q1239/Q1240	Q1241/Q1242	Q1243/Q1244	Q1245/Q1246	Q1247/Q1248	Q1249/Q1250	Q1251/Q1252	Q1253/Q1254	Q1255/Q1256	Q1257/Q1258	Q1259/Q1260	Q1261/Q1262	Q1263/Q1264	Q1265/Q1266	Q1267/Q1268	Q1269/Q1270	Q1271/Q1272	Q1273/Q1274	Q1275/Q1276	Q1277/Q1278	Q1279/Q1280	Q1281/Q1282	Q1283/Q1284	Q1285/Q1286	Q1287/Q1288	Q1289/Q1290	Q1291/Q1292	Q1293/Q1294	Q1295/Q1296	Q1297/Q1298	Q1299/Q1300	Q1301/Q1302	Q1303/Q1304	Q1305/Q1306	Q1307/Q1308	Q1309/Q1310	Q1311/Q1312	Q1313/Q1314	Q1315/Q1316	Q1317/Q1318	Q1319/Q1320	Q1321/Q1322	Q1323/Q1324	Q1325/Q1326	Q1327/Q1328	Q1329/Q1330	Q1331/Q1332	Q1333/Q1334	Q1335/Q1336	Q1337/Q1338	Q1339/Q1340	Q1341/Q1342	Q1343/Q1344	Q1345/Q1346	Q1347/Q1348	Q1349/Q1350	Q1351/Q1352	Q1353/Q1354	Q1355/Q1356	Q1357/Q1358	Q1359/Q1360	Q1361/Q1362	Q1363/Q1364	Q1365/Q1366	Q1367/Q1368	Q1369/Q1370	Q1371/Q1372	Q1373/Q1374	Q1375/Q1376	Q1377/Q1378	Q1379/Q1380	Q1381/Q1382	Q1383/Q1384	Q1385/Q1386	Q1387/Q1388	Q1389/Q1390	Q1391/Q1392	Q1393/Q1394	Q1395/Q1396	Q1397/Q1398	Q1399/Q1400	Q1401/Q1402	Q1403/Q1404	Q1405/Q1406	Q1407/Q1408	Q1409/Q1410	Q1411/Q1412	Q1413/Q1414	Q1415/Q1416	Q1417/Q1418	Q1419/Q1420	Q1421/Q1422	Q1423/Q1424	Q1425/Q1426	Q1427/Q1428	Q1429/Q1430	Q1431/Q1432	Q1433/Q1434	Q1435/Q1436	Q1437/Q1438	Q1439/Q1440	Q1441/Q1442	Q1443/Q1444	Q1445/Q1446	Q1447/Q1448	Q1449/Q1450	Q1451/Q1452	Q1453/Q1454	Q1455/Q1456	Q1457/Q1458	Q1459/Q1460	Q1461/Q1462	Q1463/Q1464	Q1465/Q1466	Q1467/Q1468	Q1469/Q1470	Q1471/Q1472	Q1473/Q1474	Q1475/Q1476	Q1477/Q1478	Q1479/Q1480	Q1481/Q1482	Q1483/Q1484	Q1485/Q1486	Q1487/Q1488	Q1489/Q1490	Q1491/Q1492	Q1493/Q1494	Q1495/Q1496	Q1497/Q1498	Q1499/Q1500	Q1501/Q1502	Q1503/Q1504	Q1505/Q1506	Q1507/Q1508	Q1509/Q1510	Q1511/Q1512	Q1513/Q1514	Q1515/Q1516	Q1517/Q1518	Q1519/Q1520	Q1521/Q1522	Q1523/Q1524	Q1525/Q1526	Q1527/Q1528	Q1529/Q1530	Q1531/Q1532	Q1533/Q1534	Q1535/Q1536	Q1537/Q1538	Q1539/Q1540	Q1541/Q1542	Q1543/Q1544	Q1545/Q1546	Q1547/Q1548	Q1549/Q1550	Q1551/Q1552	Q1553/Q1554	Q1555/Q1556	Q1557/Q1558	Q1559/Q1560	Q1561/Q1562	Q1563/Q1564	Q1565/Q1566	Q1567/Q1568	Q1569/Q1570	Q1571/Q1572	Q1573/Q1574	Q1575/Q1576	Q1577/Q1578	Q1579/Q1580	Q1581/Q1582	Q1583/Q1584	Q1585/Q1586	Q1587/Q1588	Q1589/Q1590	Q1591/Q1592	Q1593/Q1594	Q1595/Q1596	Q1597/Q1598	Q1599/Q1600	Q1601/Q1602	Q1603/Q1604	Q1605/Q1606	Q1607/Q1608	Q1609/Q1610	Q1611/Q1612	Q1613/Q1614	Q1615/Q1616	Q1617/Q1618	Q1619/Q1620	Q1621/Q1622	Q1623/Q1624	Q1625/Q1626	Q1627/Q1628	Q1629/Q1630	Q1631/Q1632	Q1633/Q1634	Q1635/Q1636	Q1637/Q1638	Q1639/Q1640	Q1641/Q1642	Q1643/Q1644	Q1645/Q1646	Q1647/Q1648	Q1649/Q1650	Q1651/Q1652	Q1653/Q1654	Q1655/Q1656	Q1657/Q1658	Q1659/Q1660	Q1661/Q1662	Q1663/Q1664	Q1665/Q1666	Q1667/Q1668	Q1669/Q1670	Q1671/Q1672	Q1673/Q1674	Q1675/Q1676	Q1677/Q1678	Q1679/Q1680	Q1681/Q1682	Q1683/Q1684	Q1685/Q1686	Q1687/Q1688	Q1689/Q1690	Q1691/Q1692	Q1693/Q1694	Q1695/Q1696	Q1697/Q1698	Q1699/Q1700	Q1701/Q1702	Q1703/Q1704	Q1705/Q1706	Q1707/Q1708	Q1709/Q1710	Q1711/Q1712	Q1713/Q1714	Q1715/Q1716	Q1717/Q1718	Q1719/Q1720	Q1721/Q1722	Q1723/Q1724	Q1725/Q1726	Q1727/Q1728	Q1729/Q1730	Q1731/Q1732	Q1733/Q1734	Q1735/Q1736	Q1737/Q1738	Q1739/Q1740	Q1741/Q1742	Q1743/Q1744	Q1745/Q1746	Q1747/Q1748