

Introduction to Aircraft Design

July-2023

Assignment 9

Q 1	Which of the following statement(s) is/are TRUE about Life Cycle Cost of an aircraft?	
MSQ (1 mark)	(A)	It is the cost incurred during the operational life.
	(B)	It is the cost incurred during the Production phase.
	(C)	It is the cost incurred during Design and Development.
	(D)	It is the cost incurred from inception to disposal.
Solution: (D)		

Q 2	Which of the following statement(s) is/are TRUE about the importance of Life Cycle Cost in aircraft design?	
MSQ (1 mark)	(A)	It helps in the selection of competing solutions.
	(B)	It helps in the identification of cost reduction areas.
	(C)	It helps in deciding which features should be included in the design.
	(D)	It helps in meeting the requirements specified by the certification agencies.
Solution: (A), (B)		

Q 3	Which of the following component of LCC has the largest effect on aircraft design?	
MCQ (1 mark)	(A)	Disposal
	(B)	Operations and Support
	(C)	Production
	(D)	Research and Development
Solution: (B)		

Q 4	Which of the following is/are problem(s) in Cost estimation?	
MSQ (1 mark)	(A)	Non-optimal production rate
	(B)	Difficult to determine actual cost
	(C)	Differences in accounting procedures
	(D)	Largely dependent on statistical data
Solution: (A), (B), (C), (D)		

Q 5	Life Cycle Cost depends on _____.	
MSQ (1 mark)	(A)	Maximum Take-off Weight
	(B)	Maximum Velocity at mission altitude
	(C)	Quantity of aircraft produced
	(D)	Amortization of DT&E cost
Solution: (A), (B), (C), (D)		

Q 6	Which of the following is/are the component(s) of RDT&E cost?	
MSQ (1 mark)	(A)	Material
	(B)	Quality control
	(C)	Flight testing
	(D)	Prototype fabrication
Solution: (A), (B), (C), (D)		

Q 7	It is assumed that the engineering staff will work 45 hrs a week for 45 weeks a year, how many engineers are required to accomplish the development over a period of 5 years, if the total engineering man-hours required are 20,56,700. (Write your answer correct to the nearest integer)
NAT (1 mark)	Answer : 204
Solution:	
$\text{No. of Engineers} = \frac{\text{Number of engineering man - hours required}}{\text{Number of engineering staff work hours per year * number of years}}$ $\text{No. of Engineers} = \frac{2056700}{45 * 45 * 5} = 203.1 \approx 204$	

Q 8	What percentage of Life Cycle Cost is typically committed and actually spent during the Concept Exploration Phase?	
MCQ (1 mark)	(A)	85% committed and 45% spent
	(B)	65% committed and 15% spent
	(C)	85% committed and 35% spent
	(D)	35% committed and 25% spent
Solution: (B)		

Q 9 - 15	<p>A passenger transport aircraft has following characteristics:</p> <p>Empty Weight: 200000 lb</p> <p>AMPR Weight (60%): 120000 lb</p> <p>Avionics Weight: 4500 lb</p> <p>Maximum Speed: 450 KEAS</p> <p>Maximum Thrust per engine: 70000 lb</p> <p>Turbine Inlet Temperature: 3100 R</p> <p>Material Fudge Factor: 2</p> <p>Production Run: 1000 aircraft</p> <p>Rate of production: 10 aircraft per month</p> <p>No. of flight test aircraft: 5</p> <p>Man hour rates:</p> <ul style="list-style-type: none"> Tooling: 130 USD/hr Engineering: 140 USD/hr Quality Control: 125 USD/hr Manufacturing: 110 US/hr <p>Avionics cost: 7000 USD per lb</p>
Q 9	<p>Estimate the Airframe Engineering cost (in Billion USD) in RDT&E phase. (Write your answer correct upto two decimal places)</p>
NAT (1 mark)	<p>Answer : 5.00-6.00</p>
<p>Solution:</p> $\text{Airframe Engineering hours} = F_M * 4.86 W_e^{0.777} V^{0.894} Q^{0.163}$ $\text{Airframe Engineering hours} = 2 * 4.86 * 200000^{0.777} * 450^{0.894} * 5^{0.163}$ $\text{Airframe Engineering hours} = 3.912 * 10^7 \text{ hours}$	

$$\text{Airframe Engineering cost} = 3.912 * 10^7 \text{ hours} * 140 \text{ USD/hr}$$

$$\text{Airframe Engineering cost} = 5.47 \text{ Billion USD}$$

Q 10	Estimate the Airframe Engineering cost (in Billion USD) in production phase. (Write your answer correct upto two decimal places)
NAT (1 mark)	Answer :12.50 - 13.50

Solution:

$$\text{Airframe Engineering hours} = F_M * 4.86 W_e^{0.777} V^{0.894} Q^{0.163}$$

$$\text{Airframe Engineering hours} = 2 * 4.86 * 200000^{0.777} * 450^{0.894} * 1000^{0.163}$$

$$\text{Airframe Engineering hours} = 9.279 * 10^7 \text{ hours}$$

$$\text{Airframe Engineering cost} = 9.279 * 10^7 \text{ hours} * 140 \text{ USD/hr}$$

$$\text{Airframe Engineering cost} = 12.99 \text{ Billion USD}$$

Q 11	Estimate the Tooling cost (in Billion USD) in RDT&E phase. (Write your answer correct upto two decimal places)
NAT (1 mark)	Answer :2.00-2.50

Solution:

$$\text{Tooling hours} = F_M * 5.99 W_e^{0.777} V^{0.696} Q^{0.263}$$

$$\text{Tooling hours} = 2 * 5.99 * 200000^{0.777} * 450^{0.696} * 5^{0.263}$$

$$\text{Tooling hours} = 1.689 * 10^7 \text{ hours}$$

$$\text{Tooling cost} = 1.689 * 10^7 \text{ hours} * 130 \text{ USD/hr}$$

$$\text{Tooling cost} = 2.19 \text{ Billion USD}$$

Q 12	Estimate the Tooling cost (in Billion USD) in production phase. (Write your answer correct upto two decimal places)
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NAT (1 mark)	Answer :8.50 – 9.00
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Solution:

$$\begin{aligned}
 \text{Tooling hours} &= F_M * 5.99 W_e^{0.777} V^{0.696} Q^{0.263} \\
 \text{Tooling hours} &= 2 * 5.99 * 200000^{0.777} * 450^{0.696} * 1000^{0.263} \\
 \text{Tooling hours} &= 6.807 * 10^7 \text{ hours} \\
 \text{Tooling cost} &= 6.807 * 10^7 \text{ hours} * 130 \text{ USD/hr} \\
 \text{Tooling cost} &= 8.84 \text{ Billion USD}
 \end{aligned}$$

Q 13	Estimate the Manufacturing Labour and QC Cost (in Billion USD) in RDT&E phase. (Write your answer correct upto two decimal places)
NAT (1 mark)	Answer :2.00 - 2.50

Solution:

$$\begin{aligned}
 \text{Manufacturing hours} &= F_M * 1.133 * 7.37 * W_e^{0.82} V^{0.484} Q^{0.641} \\
 \text{Manufacturing hours} &= 2 * 1.133 * 7.37 * 200000^{0.82} * 450^{0.484} 5^{0.641} \\
 \text{Manufacturing hours} &= 2.003 * 10^7 \text{ hours} \\
 \text{Manufacturing cost} &= 2.003 * 10^7 \text{ hours} * 110 \text{ USD/hr} \\
 \text{Manufacturing cost} &= 2.20 \text{ Billion USD}
 \end{aligned}$$

Q 14	Estimate the Manufacturing Labour and QC Cost (in Billion USD) in Production phase. (Write your answer correct upto two decimal places)
NAT	Answer :60.00 - 70.00

(1 mark)	
Solution:	
	$\text{Manufacturing hours} = F_M * 1.133 * 7.37 * W_e^{0.82} V^{0.484} Q^{0.641}$ $\text{Manufacturing hours} = 2 * 1.133 * 7.37 * 200000^{0.82} * 450^{0.484} 1000^{0.641}$ $\text{Manufacturing hours} = 5.980 * 10^8 \text{ hours}$ $\text{Manufacturing cost} = 5.980 * 10^8 \text{ hours} * 110 \text{ USD/hr}$ $\text{Manufacturing cost} = 65.78 \text{ Billion USD}$
Q 15 (1 mark)	Estimate the Total Avionics Cost (RDT&E and Production) in Billion USD. (Write your answer correct upto two decimal places)
NAT (1 mark)	Answer :30.00- 33.00
Solution:	
$\text{Avionics Weight} = 4500 \text{ lb}$ $\text{Cost of avionics per lb} = 7000 \text{ USD}$ $\text{Avionics Cost per aircraft} = 4500 * 7000 = 31.5 \text{ Million USD}$ $\text{Total number of aircraft} = 1005$ $\text{Total Avionics Cost} = 1005 * 31.5 \text{ Million USD} = 31.65 \text{ Billion USD}$	