APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Scheme for Valuation/Answer Key

Scheme of evaluation (marks in brackets) and answers of problems/key

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MAY 2019

Course Code: ME462

Course Name: Propulsion Engineering

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any three full questions, each carries 10 marks.

			Marks
1	(a)	pulsejet engines neat figure 3 marks, Explanation: 4 marks	(7)
	(b)	Pulse mode, excessive sound and vibration: 3 marks	(3)
2	(a)	turbofan engine aft or front fan neat figure 3 marks, Explanation: 4 marks	(7)
	(b)	Difference, thrust from two sources: 3 marks	(3)
3	(a)	Ideal processes only : 4 marks, actual process: 3 marks	(7)
	(b)	Turbine favourable pressure gradient, compressor adverse pressure gradient do separation: 3 marks	(3)
4		For maximum thrust power, $\sigma = \frac{u}{c_j} = 0.5$ (1 Mark)	(10)
		i)Thrust, F = $\dot{m}c_j - \dot{m_a}u$ = 6.827 kN (2 Mark)	
		ii)Thrust power = F*u=1517.09 kW (1 Mark)	
		iii)TSFC=$\frac{\dot{m_f}*3600}{F}$ =0.1898 kg/kN (2 Mark)	
		iv)Propulsive efficiency =$\frac{1}{1+\frac{c_j}{u}}$ =66.6 % (2 Mark)	
		v)Assume Calorific Value of fuel Q_f= 43 MJ/kg	
		Thermal efficiency=$\frac{\frac{1}{2}\dot{m}\left(c_j^2-u^2\right)}{\dot{m_f}*Q_f}$=14.53 % (2 Mark)	

PART B

Answer any three full questions, each carries 10 marks.

5	(a)	Explanation of 3 thrust augmentation methods -6, afterburner (long range)-1	(7)
	(b)	Atleast 6 differences (3 Marks)	(3)
6	(a)	Axial flow compressor (1) atleast 3 reasons (3)	(4)
	(b)	Figures of any 2 types of combustion chambers (3) Explanation (3)	(6)
7	(a)	Explanation-(3) Advantages (1)	(4)
	(b)	Specific Impulse=142.71 seconds, effective jet velocity= 1400 m/s, actual	(6)

velocity=1398.9 m/s, SPC=0.007/s (4 X 1.5= 6 Marks)

8 (a) Figure (1) Working (2) Advantages (1) disadvantages (1) (5)

(b) Figure (3) Explanation (2) (5)

PART C

Answer any four full questions, each carries 10 marks.

9 Explanation of combustion instability in SPR or LPR - 8-mark, Control of instability-2 mark. (10)

10 Explanation with diagrams-5 (SPR)+5 (LPR)=10 mark (10)

11 (a) Working of Hybrid Rocket- explanation (3 marks) (5)

Sketch and proper labelling of components(2 marks)

(b) Explanation - 5 mark (5)

12 (a) Multi Staging explanation-3 mark, Equation for velocity increment-2 mark (5)

(b) Explanation-5 mark (5)

13 Derivation- 10 mark (Adequate weightage up to 6 mark for intermediate steps). (10)

14 (10)

Single stage

$\Delta V = I_{sp}\, g_e \ln(M_o/M_B) = 3000 \ln\{(15000/(1000+3000)\} = 3965$ m/s --**(4 marks)**

Two stage with identical stages

$\Delta V = 2 \times \{I_{sp}\, g_e \ln(M_o/M_B)\}$

$\Delta V = 2 \times I_{sp}\, g_e \ln\{(1+\lambda)/(\varepsilon+\lambda)\}$

Identical stages implies at both stages the payload mass fraction and the structural mass fraction will be the same

(ie) $\lambda_1 = \lambda_2$ and $\varepsilon_1 = \varepsilon_2$

$\lambda_1 = M_{02} / (M_{01} - M_{02})$ and $\lambda_2 = M_L / (M_{02} - M_L)$

Equating the above equations we get

$$\frac{M_{o2}}{M_{o1}-M_{o2}} = \frac{M_L}{M_{o2}-M_L}$$

Solving we get $M_{o2} = \sqrt{M_L M_{o1}}$

$= \sqrt{1000 \times 15000}$

$= 3872.98$ kg

$\therefore \lambda_1 = \frac{3872.98}{15000 - 3872.98} = 0.348$

Also $\epsilon_1 = \frac{M_{s1}}{M_{o1} - M_{o2}}$ & $\epsilon_2 = \frac{M_{s2}}{M_{o2} - M_L}$

Equating $\frac{M_{s1}}{M_{o1}-M_{o2}} = \frac{M_{s2}}{M_{o2}-M_L}$

$M_{s1}\left(\frac{M_{o2}-M_L}{M_{o1}-M_{o2}}\right) = M_{s2}$.

$0.258 \times M_{s1} = M_{s2}$. — (1)

Also $M_{s1} + M_{s2} = 3000$ — (2).

From (1) & (2). $\therefore$ $M_{s1} = 2384.86$ kg

$M_{s2} = 615.4$ kg

$\epsilon = 0.214$

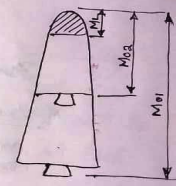
For identical 2-stage

$\Delta V = 2 \times I_{sp} g_0 \ln\left(\frac{1+\lambda}{\lambda+\epsilon}\right)$

$= 2 \times 3000 \ln\left(\frac{1+0.348}{0.348+0.214}\right)$

$= 5249.25$ m/s

$\therefore$ it is clear that the ΔV produced in 2-stage is better than single stage.



------(6 marks)

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