Unit 14 - Week 12: Hybrid Propellant Rocket Engine and Non-chemical Rocket Engine

Week 12: Assignment

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2019-10-23, 23:59 IST.

1) Heat transfer by the hot gas at the throat of the nozzle will be much higher as compared to its other regions. Given statement is: *1 point*

- True
- False

No, the answer is incorrect.
Score: 0
Accepted Answers:
True

2) The specific impulse of the hybrid propellant rocket engine (HPRE) is higher as compared to the liquid propellant rocket engine. Given statement is: *1 point*

- True
- False

No, the answer is incorrect.
Score: 0
Accepted Answers:
False

3) Multi-port grain is preferred in HPRE to achieve higher fuel consumption rate. Given statement is: *1 point*

- True
- False

No, the answer is incorrect.
Score: 0
Accepted Answers:
True

4) Chemical propellants have higher thrust level as compared to the non-chemical rocket propellants. Given statement is: *1 point*

- True
- False

No, the answer is incorrect.
Score: 0
Accepted Answers:
True

5) At low mass flux, the effect of radiation on regression rate is quite insignificant in HPRE. Given statement is: *1 point*

- True
- False

No, the answer is incorrect.
Score: 0
Accepted Answers:
False

6) Which of the following affects the regression rate of solid fuel grain in HPRE *1 point*

- Atomizer design
- Fuel port size
- Type of fuel
- All of the mentioned above

No, the answer is incorrect.
Score: 0
Accepted Answers:
All of the mentioned above

7) Volumetric efficiency of HPRE is not influenced by: *1 point*

- Number of ports
- Oxidizer mass flux
- Web thickness
- Thrust level

No, the answer is incorrect.
Score: 0
Accepted Answers:
Thrust level

8) Which of the following port configuration is having least structural strength among all: *1 point*

- Cylindrical
- Double-D
- 4-port wagon wheel
- 40-Wagon wheel

No, the answer is incorrect.
Score: 0
Accepted Answers:
40-Wagon wheel

9) Identify the incorrect statement with respect to the hybrid propellant rocket engine: *1 point*

- Specific impulse remains constant during steady state operation.
- It has ability to change thrust level smoothly over a wide range.
- It has relatively lower system cost as compared to LPRE.
- It has higher safety envelop during storage and operation as compared to SPRE and LPRE.

No, the answer is incorrect.
Score: 0
Accepted Answers:
Specific impulse remains constant during steady state operation.

10) At which location the regression rate is constant and most stable in circular port of a hybrid propellant: *1 point*

- Upstream
- Downstream
- Near to the entrance
- None of these

No, the answer is incorrect.
Score: 0
Accepted Answers:
Downstream

11) Consider the following problem statement to answer questions from Q11-13 *1 point*

A 2 kW electro-thermal rocket engine with helium as propellant is designed and developed for obtaining the thrust coefficient of 1.6. The temperature should not exceed the temperature limit of tungsten filament (3200 K). Assume the mass flow rate of propellant to be 0.25 g/s and thruster efficiency of 0.8.

The exit velocity is:

- 2322 m/s
- 2779 m/s
- 3578 m/s
- 4149 m/s

No, the answer is incorrect.
Score: 0
Accepted Answers:
3578 m/s

12) Temperature of propellant gas is: *2 points*

- 1282 K
- 1851 K
- 2028 K
- 2664 K

No, the answer is incorrect.
Score: 0
Accepted Answers:
1282 K

13) Total thrust developed by the electrochemical rockets is: *1 point*

- 0.89 N
- 4.89 N
- 7.51 N
- 9.25 N

No, the answer is incorrect.
Score: 0
Accepted Answers:
0.89 N

14) Consider the following problem statement to answer questions from Q14-17 *1 point*

A hybrid propellant rocket engine produces thrust of 2 MN with characteristics velocity of 2225 m/s and thrust coefficient of 1.8 using HTPB fuel and liquid oxidizer. The oxidizer fuel mass flow rate ratio is 4.5 whereas the chamber pressure and chamber temperature are 5 MPa and 2900 K respectively. The fuel grain diameter is 0.3 m with total length of 3.2 m.
Consider empirical relation for regression rate:
$\rho_f(r) = 0.036 G^{0.8} (x/\mu)^{-0.2} B^{0.23}$
and $B \sim 18$ & $\mu_g \sim 2 \times 10^{-5}$ *Pa.s*)

The mass flow rate of fuel is:

- 33.6 kg/s
- 56.6 kg/s
- 89.9 kg/s
- 156.7 kg/s

No, the answer is incorrect.
Score: 0
Accepted Answers:
89.9 kg/s

15) The mass flow rate of oxidizer is: *1 point*

- 257.4 kg/s
- 211.4 kg/s
- 151.2 kg/s
- 404.5 kg/s

No, the answer is incorrect.
Score: 0
Accepted Answers:
404.5 kg/s

16) Which of the following expression correctly represents the expression of regression rate: (R_i is the port radius) *2 points*

- $\rho_f(r) = 0.364/R_i^{1.6}$
- $\rho_f(r) = 1.486/R_i^{1.6}$
- $\rho_f(r) = 2.884/R_i^{1.6}$
- $\rho_f(r) = 3.567/R_i^{1.6}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\rho_f(r) = 0.364/R_i^{1.6}$

17) The port diameter is: *1 point*

- 13.7 mm
- 20.9 mm
- 27.5 mm
- 32.3 mm

No, the answer is incorrect.
Score: 0
Accepted Answers:
27.5 mm

18) Consider the following problem statement to answer questions from Q18-20 *2 points*

Hot gas at total temperature of 2300 K with 320 m/s is flowing inside a combustion chamber of a rocket engine with diameter of 0.5 m causing immense heating to its metal wall. The combustion chamber is cooled by regenerative cooling to maintain its outer wall temperature at 290 K whereas the inner wall temperature is 1000 K. The wall thickness happens to be 5 mm with thermal conductivity of 21 W/m · K. The emissivity of the radiation heat loss due to gas is 0.9.

Consider following properties for the hot gas: $\rho_g = 0.8$ kg/m^3, $\mu_g \sim 2.5 \times 10^{-5}$ *Pa.s*, $Pr = 0.83$, $k_g = 0.18$ W/m.K and use semi empirical relationship for Nusselt number $Nu = 0.026\, Re^{0.8} Pr^{0.4}$

Convective heat transfer coefficient of hot gas inside the chamber is:

- 1945 W/m^2.K
- 2024 W/m^2.K
- 2443 W/m^2.K
- 2872 W/m^2.K

No, the answer is incorrect.
Score: 0
Accepted Answers:
2024 W/m^2.K

19) Total heat loss per unit area is: *2 points*

- 3035 kW
- 3385 kW
- 3572 kW
- 3937 kW

No, the answer is incorrect.
Score: 0
Accepted Answers:
3937 kW

20) The fraction of radiation heat loss with respect to the total heat loss: *1 point*

- 0.33
- 0.38
- 0.25
- 0.28

No, the answer is incorrect.
Score: 0
Accepted Answers:
0.33