VM433 FA2016 Project 2 Part B Sample Answer

Please note that not all the required answers are provided. You need to read the project description carefully. You may check with TA if you cannot get the correct number. If there is any typo in the file, please inform the TA as well.

Given the following input data:

Table 1 Cycle Parameters

Basic cycle parameters	Figure of merit	Value
Low-pressure compressor, LPC	Pressure ratio	3.5
Overall cycle	Pressure ratio	40
Turbine inlet	Temperature	1350 ℃

Table 2 Device Performance Metrics

LMS100 engine component	Figure of merit	Value
Low-pressure compressor, LPC	Polytropic efficiency	0.85
High-pressure compressor, HPC	Polytropic efficiency	0.80
High-pressure turbine, HPT	Polytropic efficiency	0.80
Intermediate-pressure turbine, IPT	Polytropic efficiency	0.85
Power turbine, PT	Polytropic efficiency	0.88
Intercooler	Pinch temperature difference	25 K
	Pressure loss ratio	0.90
Burner	Pressure loss ratio	0.90

Table 3 Fuel and Air Components

Fuel component	mol%	Air component	mol%
Methane	92.0	Oxygen	28.50
Ethane	4.0	Nitrogen	69.05
Propane	2.0	Argon	0.92
Nitrogen	1.0	Carbon dioxide	0.03
Carbon dioxide	0.5	Water	1.50
Oxygen	0.5		

Part B4:

If you apply **Table 1**, **Table 2** and air components in **Table 3**:

```
The thermal efficiency is:           39.45 %
The heat rate is:                    9126.40 kJ/kWh
The specific work is:                420.43 kW/(kg/s)
The turbine exhaust temperature is:  789.07 K or 515.92 deg C
```

Part B5:

(a) Given air components in **Table 3**, the properties for air should be:

(1) At T = 288.15 K, P = 101.3 kPa,

we have v = 0.8124 m^3/kg, h = -138.66 kJ/kg, s = 6.666 kJ/(kg·K)

(2) At T = 313.15 K, P = 319.1 kPa,

we have v = 0.2803 m^3/kg, h = -113.60 kJ/kg, s = 6.422 kJ/(kg·K)

(b) If the fuel is pure methane (CH_4):

Stoichiometric amount of air = 7.0175 kmol / kmol of fuel supplied

Corresponding stoichiometric amount of complete combustion product species

(in kmol / kmol of fuel supplied):

O_2 = 0 N_2 = 4.8456 Ar = 0.0646 CO_2 =1.0021 H_2O = 2.1053

Part B6:

If you apply **Table 3**:

(1) Suppose fuel temp. = 300 K, air temp. = 300 K and *AF* = 30, then *AFT* = 1568.36 K

(2) Suppose fuel temp. = 300 K, air temp. = 300 K and *AFT* = 2000 K, then *AF* = 20.73

Part B7:

If you apply **Table 1**, **Table 2** and **Table 3**:

```
The thermal efficiency is:           32.39 %
The heat rate is:                    11113.29 kJ/kWh
The specific work is:                498.93 kW/(kg/s)
The turbine exhaust temperature is:  819.54 K or 546.39 deg C
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