

Reg No.: \_\_\_\_\_

Name: \_\_\_\_\_

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**  
FOURTH SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2018

**Course Code: ME204**

**Course name: THERMAL ENGINEERING**

Max. Marks: 100

Duration: 3 Hours

*Use of steam tables permitted*

**Part A**

*Answer any three questions*

1. a) Draw the p-v and T-s diagram of a modified Rankine cycle. Clearly denote all the processes involved. **(4 marks)**  
b) Superheated steam ( $c_p = 2.1$  kJ/kg K) at a pressure of 10 bar and  $400^\circ\text{C}$  is supplied to a steam engine. Adiabatic expansion takes place to release point at 0.9 bar and it exhausts into a condenser at 0.3 bar. Neglecting clearance, determine: (i) Quality of steam at the end of expansion and the end of constant volume operation. (ii) Modified Rankine cycle efficiency. **(6 marks)**
2. Show the constructional details of a Locomotive boiler using a neat diagram. **(10 marks)**
3. a) Draw the combined velocity diagram for a moving blade of a single stage impulse steam turbine. Clearly denote all the components. **(4 marks)**  
b) Define the terms: (i) Degree of reaction. (ii) Stage efficiency. (iii) Reheat factor. **(6 marks)**
4. In an impulse steam turbine, steam issues from the nozzle with a velocity of 1200 m/s. The nozzle angle is  $20^\circ$  and the mean blade velocity is 400 m/s. The inlet and outlet blade angles are equal. The blade velocity coefficient is 0.8. The mass of steam flowing through the turbine per hour is 950 kg. Calculate: (i) Blade angles. (ii) Relative velocity of steam entering the blades. (iii) Tangential force on the blades. (iv) Power developed. (v) Blade efficiency. **(10 marks)**

**Part B**

*Answer any three questions*

5. The compression ratio for a dual cycle single cylinder engine with 3 working cycles per second, is 9. The maximum pressure in the cycle is limited to 60 bar. The pressure and temperature of air at the beginning of the cycle is 1 bar and  $30^\circ\text{C}$ . Heat is added during constant pressure

process upto 4% of the stroke. Take cylinder diameter as 250 mm and stroke length as 300 mm. Determine: (i) The air standard efficiency of the cycle. (ii) The power developed. Take  $c_p = 1.005 \text{ kJ/kg K}$  and  $c_v = 0.718 \text{ kJ/kg K}$  for air. **(10 marks)**

6. a) What is the purpose of supercharging of I. C. engines? Mention two applications where supercharging of engines is necessary. **(4 marks)**
- b) Show that efficiency of stirling cycle is same as that of carnot cycle if they are operating at same temperature limits. **(6 marks)**
7. A 4-cylinder four stroke petrol engine is working based on the following data: Air-fuel ratio by weight = 15:1, calorific value of the fuel = 45000 kJ/kg, mechanical efficiency = 80%, air-standard efficiency = 54%, relative efficiency = 70%, volumetric efficiency = 75%, stroke/bore ratio = 1.25, suction conditions = 1 bar and 30°C, r.p.m. = 2500, brake power = 70kW. Calculate: (i) Compression ratio. (ii) Indicated thermal efficiency. (iii) Brake specific fuel consumption. (iv) Bore and stroke. **(10 marks)**
8. a) Explain how frictional power can be obtained using Morse test? **(4 marks)**
- b) The percentage composition of a sample of liquid fuel by weight is C = 85% and H<sub>2</sub> = 15%. Calculate: (i) the weight of air needed for combustion of 1 kg of fuel. (ii) The volumetric composition of the products of combustion, if 16% of excess air is supplied. **(6 marks)**

### Part C

#### *Answer any four questions*

9. a) What are the causes of hydrocarbon emissions? How HC emissions contributes to air pollution? **(4 marks)**
- b) Explain octane and cetane rating of fuels? **(6 marks)**
10. With the help of a practical pressure-crank angle diagram, explain the different stages of combustion in S.I. engines. **(10 marks)**
- 11.a) What are the advantages and disadvantages of direct injection combustion chambers for C.I. engines? **(4 marks)**
- b) Write short notes on alternative fuels and biofuels. **(6 marks)**
12. a) How are gas turbines classified? Compare gas turbines and I. C. engines, based on speed and mechanical efficiency. **(4 marks)**

- b) Air enters the compressor of a gas turbine plant operating on Brayton cycle at 1 bar, 30°C. The pressure ratio in the cycle is 7. Calculate the maximum temperature in the cycle and the cycle efficiency. Assume turbine work is 2.5 times the compressor work. Take the ratio of specific heats as 1.4. **(6 marks)**
13. Air enters the compressor of an open cycle constant pressure gas turbine at a pressure of 1 bar and temperature of 30°C. The pressure of the air after compression is 5 bar. The isentropic efficiencies of compressor and turbine are 80% and 85% respectively. The air-fuel ratio used is 80:1. If the flow rate of air is 3.0 kg/s, find: (i) Power developed. (ii) Thermal efficiency of the cycle. Take calorific value of fuel as 42000 kJ/kg. Assume  $c_p = 1.005$  kJ/kg K and  $\gamma = 1.4$  for air and gases. **(10 marks)**
14. (a) Explain three methods for the improvement of efficiency of open cycle gas turbine power plant with necessary T&S diagrams. **(6 marks)**
- (b) Derive expression for efficiency of ideal Joule Cycle. **(4 marks)**

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