

Reg. No. _____ Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FOURTH SEMESTER B.TECH DEGREE EXAMINATION, JUNE 2017

ME204: THERMAL ENGINEERING (ME)

Max. Marks: 100

Duration: 3 Hours

PART A

Answer any 3 questions. Ten marks each.

1. Explain the methods of increasing the thermal efficiency of a Rankine cycle.
2. Compare the characteristic features of a fire tube boiler and water tube boiler.
3. Discuss the methods of energy transfer in impulse and reaction turbines.
4. A simple Rankine cycle works between pressure 28 bar and 0.06 bar, the initial condition of the steam being dry saturated. Calculate the cycle efficiency.

PART B

Answer any 3 questions. Ten marks each.

5. Compare a 2 stroke and 4 stroke engines. Which engine do you prefer for two wheelers? Why?
6. Define Flash point, Fire point, Calorific value, volatility and carbon residue of a fuel.
7. Explain the working of a Rotary Engine and Stratified Charge Engine.
8. Explain turbo charging and super charging. How does it affect the engine performance and pollution levels?

PART C

Answer any 4 questions. Ten marks each.

9. Show that efficiency of an ideal Stirling cycle is same as that of Carnot cycle, both operating under same temperature limits.
10. Compare the Otto cycle and actual cycle with p-v diagram. Explain the effect of variable specific heats on the performance and efficiency of an Otto Cycle.
11. Define i. Equivalence Ratio, ii. Mean Effective Pressure, iii. Specific fuel consumption, iv. Flash Point and v. Time loss factor.
12. Compare the various stages of combustion in SI and CI engine with p- θ diagram.
13. In an engine working on diesel cycle inlet pressure and temperature are 1 bar and 17⁰C respectively. Pressure at the end of adiabatic compression is 35 bar. The ratio of

expansion (ie, after the constant pressure heat addition) is 5. Calculate the heat supplied and Efficiency. Also find Mean Effective Pressure by considering air as ideal gas.

14. The velocity of steam entering simple impulse turbine is 1000 m/s, and the nozzle angle is 20. The mean velocity of blades is 400 m/s and the blades are symmetrical. If the steam is to enter the blades without shock, what will be the blade angles?
Neglecting friction effects on the blades calculate the tangential force on the blades and the diagram power for a mass flow of 0.75kg/s, estimate the axial thrust and diagram efficiency. If the relative velocity at exit is reduced by friction to 80% of that at inlet estimate the axial thrust, diagram power and diagram efficiency.

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FOURTH SEMESTER B.TECH DEGREE EXAMINATION, JULY 2017

Course Code: **ME204**

Course Name: **THERMAL ENGINEERING (ME)**

Max. Marks: 100

Duration: 3 Hours

PART A

Answer any three questions.

1. Draw neat sketches of a Cochran and Babcock Wilcox boiler. List the boiler mountings and accessories used in a boiler. Compare the merits and demerits of water tube and fire tube boilers. (10)
2. In a Rankine cycle the steam at inlet to turbine is saturated at a pressure of 35bar and exhaust pressure is 0.2bar. Determine i) The pump work ii) The turbine work iii) The Rankine efficiency iv) The condenser heat flow v) The dryness fraction at the end of expansion. Take a flow rate of 10kg/sec (10)
3. a) Derive the relationship for optimum blade speed ratio for an impulse turbine in terms of inlet nozzle angle. Show that maximum blade or diagram efficiency is given by $\cos^2 \alpha_1$ (5)
 b) The velocity of steam leaving nozzles of an impulse turbine is 900m/s and the nozzle angle is 20° . Blade velocity is 300m/s and blade velocity coefficient is 0.7. Calculate for a mass flow rate of 1kg/Sec and symmetrical blading i) The blade inlet angle ii) Driving force on wheel iii) The axial thrust iv) Diagram power v) Diagram efficiency. (5)
4. A Parsons reaction turbine running at 400rpm with 50% reaction develops 75KW per kg of the steam. The exit angle of the blade is 20° and the steam velocity at inlet is 1.4 times blade velocity. Determine i) Blade velocity ii) Blade inlet angle. (10)

PART B

Answer any three questions.

5. a. Derive an expression for air standard efficiency of an Otto cycle citing all assumptions involved (4)
 b. In an Otto cycle air at 17°C and 1 bar is compressed adiabatically until the pressure is 15bar. Heat is added at constant volume until the pressure rises to 40bar. Calculate the air standard efficiency, compression ratio and maximum temperature in the cycle. $C_v=0.717 \text{ KJ/KgK}$ and $R_0=8.314 \text{ KJ/KmolK}$. (6)
6. a. Explain the operation of a wankel engine. (4)
 b. Draw line sketch showing the gas flow routes and components and explain the supercharging and turbo charging with respect to IC engines. (4)
 c. Out of CI and SI engines, which engine is more suitable to supercharging? Explain. (2)

7. During brake test of a four cylinder 4 stroke engine coupled to a dynamometer at constant speed, the following results are obtained. BP with all cylinders working=14.7kw. BP with cylinder 1 cut off=10.14kw. BP with cylinder 2 cut off =10.3kw. BP with cylinder 3 cut off =10.36kw. BP with cylinder 4 cut off=10.21kw. Petrol consumption=5.5kg/hr.CV of fuel=42000 Kj/Kg. Diameter of cylinder=8cm, Stroke of piston=10cm, Clearance volume 0.1 litre. Calculate i) The mechanical efficiency ii) Relative efficiency on the basis of IP. (10)
8. a. What are octane and cetane ratings? Mention important doping agents used to control the values of octane number. (4)
- b. Determine the air fuel ratio and the theoretical amount of air required by mass for complete combustion of fuel containing (by mass) 85% carbon, 8% hydrogen, 3% oxygen, 1% sulphur and remaining ash. If 40% excess air is used what is the volume of air at 27°C and 1.03bar. (6)

PART C

Answer any four questions.

9. a. With a p-θ diagram, explain various stages of an SI engine combustion. (4)
- b. Explain the influence of various factors that reduce Knock in SI engine. (6)
10. a. What are the important factors to be considered for the design of CI engine combustion chamber? (4)
- b. With sketches, discuss various designs of Indirect (Divided) Combustion chambers. (6)
11. a. What are various pollutants coming out of an IC engine? (3)
- b. Explains methods for control of NO_x. (3)
- c. Explain the operation of a thermal and catalytic converter. (4)
12. Air enters the compressor of an ideal air standard Brayton cycle at 100Kpa, 300K and is compressed to 1000Kpa. The temperature at the inlet to the first turbine is 1400K. The expansion takes is entropically in two stages with reheat to 1400K between two stages at a constant pressure of 300Kpa. Regenerator effectiveness 100%. Determine thermal efficiency of the cycle. (10)
13. a. Show that optimum intermediate pressure for a two stage compressor is given by $(P_1P_2)^{0.5}$ where P_1 and P_2 are initial and final pressures. (6)
- b. Discuss the stability loop of a gas turbine combustion chamber. (4)
14. a. Draw the combustion chamber of a gas turbine showing air entries at various stages. (4)
- b. An ideal gas turbine cycle with two stages of compression and two stages of expansion has an overall pressure ratio of 8. Air enters each stage of compressor at 300K and each stage of turbine at 1300K. Determine the work ratio and thermal efficiency of cycle. Assume regenerator efficiency of 100%. (6)

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

Course Code: ME204
Course Name: THERMAL ENGINEERING (ME)
Use of Steam Tables Permitted

Max. Marks: 100

Duration: 3 Hours

PART A*Answer any three full questions, each carries 10 marks*

Marks

- | | | |
|---|--|-----|
| 1 | a) List one advantage and one disadvantage of the reheat cycle and of the regenerative cycle. | (2) |
| | b) In a reheat Rankine cycle, steam at a pressure of 40 bar and 300°C is expanded through a turbine to a pressure of 4 bar. It is then heated at a constant pressure to 300°C and then expanded to 0.1 bar. Estimate the work done per kg of steam flowing through the turbine, the amount of heat supplied during the reheat process and the cycle efficiency. Neglect pump work. | (8) |
| 2 | a) What is meant by reheat factor? List the parameters influencing the value of reheat factor. | (3) |
| | b) Derive the condition for maximum efficiency of a reaction turbine. | (7) |
| 3 | a) Dry saturated steam enters a frictionless adiabatic nozzle with negligible velocity at a temperature of 300°C. It is then expanded to a pressure of 40 bar. For a mass flow rate of 2 kg/s, calculate the exit velocity of the steam. Use Mollier chart | (3) |
| | b) In an equiangular, simple impulse turbine, steam issues from the nozzles with a velocity of 900 m/s. Nozzle angle is 20° and mean blade velocity is 360 m/s. Assuming frictionless blades, for a mass flow rate of 1000 kg/ min, calculate the blade angles, the power developed in kW and the blade efficiency | (7) |
| 4 | a) With the aid of a neat sketch, explain the working of a Cochran Boiler | (7) |
| | b) Explain the metastable flow in a nozzle with h-s diagram. | (3) |

PART B*Answer any three full questions, each carries 10 marks*

- | | | |
|---|---|-----|
| 5 | a) Prove that the efficiency of Sterling cycle and Carnot cycle are equal if they are operating between the same temperature reservoirs. | (4) |
| | b) An engine working on ideal Otto cycle has a temperature of 300 K at the beginning of compression. If the ideal air standard efficiency is 50%, calculate the compression ratio of the engine. If the peak temperature of the cycle is 1150K, calculate the heat supplied and net work output of the cycle per kg of air. | (6) |
| 6 | a) Write four desirable properties of an S.I. engine fuel. | (4) |
| | b) A four-cylinder petrol engine has an output of 4.8 kW at 180 rpm. A Morse test is carried out and the brake torque readings with each cylinder cut-off in turn are 177 Nm, 170 Nm, 169 Nm and 173 Nm respectively. For normal running at this speed, the specific fuel consumption is 0.364 kg / kWh with respect to brake power. The calorific value of the fuel is 42 MJ / kg. Calculate the mechanical efficiency and brake thermal efficiency of the engine. | (6) |

- 7 a) List 2 major advantages and disadvantages of four stroke engine over two stroke engines. (4)
- b) The percentage by composition of a sample of liquid fuel by weight is C=84.8% and H₂= 15.2%. Calculate: (6)
- i)The weight of air needed for the combustion of 1 kg of fuel.
- ii)The volumetric composition of the products of combustion if 15% excess air is used.
- 8 a) Describe Retardation test and its application (4)
- b) Derive an expression for the efficiency of the air standard Diesel cycle in terms of the cycle compression ratio and cut-off ratio. (6)

PART C

Answer any four full questions, each carries 10 marks

- 9 a) What is meant by pre-ignition? Does pre-ignition occur in CI engines? Justify your answer. (3)
- b) Name the stages of combustion in a C.I. engine and explain with the aid of a pressure – crank angle diagram. (7)
- 10 a) List any 2 methods for reducing NO_x emission and discuss their basic principle (5)
- b) Name the factors affecting detonation in S.I. engine and discuss their effect. (5)
- 11 a) Explain octane rating and cetane rating? (4)
- b) In an ideal gas turbine plant, air enters the compressor at 1.03 bar and 35°C. the pressure ratio is 6. The temperature at the turbine inlet is 1200°C. Mass flow rate of air is 10 kg/s. Determine: (6)
- i) Power required to run the compressor ii)Turbine power output
- iii) Net power output of plant iv)Thermal efficiency
- For air, take: Cp = 1.005 kJ/kg.K and ratio of specific heats as 1.4.
- 12 a) Write short notes on alternative fuels and bio-fuels. (5)
- b) With the aid of a diagram, explain the working of an annular combustion for gas turbines. (5)
- 13 Air is drawn in a gas turbine unit at 15°C and 1.01 bar and pressure ratio is 7:1. (10)
- The compressor is driven by high pressure (HP) turbine and low pressure (LP) turbine drives a separate power shaft. The isentropic efficiencies of compressor, and the HP and LP turbine are 0.82,0.85 and 0.85 respectively. If the maximum cycle temperature is 610°C, calculate:
- i)The pressure and temperature of gases entering the turbine
- ii) The net power developed by the turbine
- iii) The work ratio
- iv)The thermal efficiency of the unit
- 14 a) Derive an expression for the optimum cooling pressure for minimum compressor work for a two-stage compression with perfect intercooling (4)
- b) Explain any three methods to improve the efficiency of gas turbine. (6)

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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 ($c_p = 2.1 \text{ kJ/kg K}$) at a pressure of 10 bar and 400°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° 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°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 H₂ = 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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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FOURTH SEMESTER B.TECH DEGREE EXAMINATION(R&S), MAY 2019

Course Code: ME204

Course Name: THERMAL ENGINEERING (ME)

Max. Marks: 100

Duration: 3 Hours

Use of Approved Data Book is Permitted

PART A

Answer any three full questions, each carries 10marks.

Marks

- | | | |
|---|---|------------|
| 1 | An ideal Rankine cycle employs steam as working fluid. Saturated vapor enters the turbine at 80 bar and saturated liquid exits the condenser at a pressure of 0.08 bar. The net power output of the cycle is 100 MW. Both turbine and the pump have an isentropic efficiency of 85%. Determine for the cycle (a) the thermal efficiency, (b) the mass flow rate of the steam, and (c) the rate of heat transfer into the working fluid as it passes through the boiler. | (10) |
| 2 | In a single heater regenerative cycle the steam enters the turbine at 30 bar, 400°C and the exhaust pressure is 0.1 bar. The feed water heater is a direct contact type which operates at 5 bar. Find 1) the efficiency and specific steam consumption of the cycle, 2) Increase in efficiency and specific steam consumption as compared to cycle without regeneration. Pump work may be neglected | (10) |
| 3 | a) Explain 'Reheat Factor'. Why is its magnitude always greater than unity?
b) Define the term degree of reaction as applied to a steam turbine. Show that for Parson's reaction turbine the degree of reaction is 50%. | (4)
(6) |
| 4 | Explain the working of Babcock-Wilcox boiler with neat sketch and differentiate between fire tube and water tube boiler. | (10) |

PART B

Answer any three full questions, each carries 10marks.

- | | | |
|---|--|------------|
| 5 | a) Compare Otto and Diesel cycle for i) same compression ratio and heat input, ii) same maximum pressure and heat input.
b) Explain the supercharging of engine. | (4)
(6) |
| 6 | In an engine working on Diesel cycle, inlet pressure and temperature are 1 bar and 17°C respectively. Pressure at the end of adiabatic compression is 35 bar. After constant pressure heat addition, the ratio of expansion is 5. Calculate i) heat addition, ii) heat rejection and iii) efficiency of the cycle. Assume $\gamma = 1.4$, $C_p = 1.004$ kJ/kg K and $C_v = 0.717$ kJ/kg | (10) |
| 7 | a) Sketch the heat balance curves for C I Engine at constant speed and discuss the nature of curve.
b) Describe Morse test. What are the assumptions made in this test? | (4)
(6) |
| 8 | a) Explain flash point, fire point and calorific value of fuels.
b) Explain the working of a rotary engine with a neat sketch. | (6)
(4) |

PART C

Answer any four full questions, each carries 10marks.

- 9 a) What are the basic requirements of a good combustion chamber (4)
b) “Factors tending to increase detonation in S I Engine tend to reduce knock in C I Engine”. Explain the validity of the above statement. (6)
- 10 a) Write a short note on alternate fuels for IC engines. (5)
b) What is EGR? Explain how EGR reduces NO_x emission. (5)
- 11 a) Write a short note about the pollutants from SI and CI engines. (4)
b) Explain the stages of combustion in C I Engine. (6)
- 12 At the design speed the following data apply to a gas turbine set employing a heat exchanger: Isentropic efficiency of compressor = 75%, Isentropic efficiency of turbine = 85%, Combustion efficiency = 98%, Mechanical Transmission efficiency = 99%, Mass rate of air = 22.7 kg/sec, Pressure ratio = 6:1, Heat exchanger effectiveness = 75%, Maximum cycle temperature = 1000 K. The ambient air pressure and temperature are 15°C and 1.013 bar respectively. Assuming no pressure loss in heat exchanger and combustion chamber, calculate the net power output, specific fuel consumption and thermal efficiency of the cycle. Take calorific value of fuel as 43125 kJ/kg, $c_p = 1.005$ kJ/kg K and $\gamma = 1.4$ during compression and $c_p = 1.147$ kJ/kg K and $\gamma = 1.33$ during heating and expansion. (10)
- 13 In an open cycle constant pressure gas turbine, air enters the compressor at 1.02 bar and 27°C. The pressure of air after the compression is 4.08 bar. The isentropic efficiencies of the turbine and compressor are 80% and 85% respectively. The air fuel ratio used is 80:1. Find the power output and thermal efficiency of the cycle if the flow rate of air is 2.5 kg/sec. Take $c_p = 1$ kJ/kg K and $\gamma = 1.4$ for air and gases. Calorific value of fuel used is 41720 kJ/kg. (10)
- 14 a) Derive an expression for thermal efficiency of Brayton cycle. Represent Brayton cycle in P_v and T_s diagrams. (5)
b) Discuss the means of improving the specific output and thermal efficiency of the simple open cycle gas turbine plant. (5)

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FOURTH SEMESTER B.TECH DEGREE EXAMINATION(S), DECEMBER 2019

Course Code: ME204

Course Name: THERMAL ENGINEERING

Max. Marks: 100

Duration: 3 Hours

Use of Approved data books are permitted

PART A

Answer any three full questions, each carries 10marks.

Marks

- | | | |
|---|---|------|
| 1 | Steam at a pressure of 15 bar and 250°C is expanded through a turbine to a pressure of 4 bar. It is then reheated at constant pressure to 250 °C and finally expanded to 0.1 bar. Find out the efficiency of this cycle. What will be the efficiency without reheating? Pump work can be neglected. | (10) |
| 2 | a) Derive the expression for critical pressure for maximum discharge through a nozzle. | (7) |
| | b) Discuss the merits and demerits of water tube boiler over fire tube boiler. | (3) |
| 3 | What do you meant by governing of steam turbine? Explain different methods of governing. | (10) |
| 4 | a) Differentiate between impulse and reaction turbines. | (4) |
| | b) Define i) stage efficiency ii) degree of reaction iii) reheat factor. | (6) |

PART B

Answer any three full questions, each carries 10marks.

- | | | |
|---|--|------|
| 5 | a) Compare two stroke and four stroke engines. | (4) |
| | b) Prove that efficiency of Ericsson cycle is same as that of Carnot cycle | (6) |
| 6 | a) Explain the concept of stratified charge engines and mention its advantages over conventional engines. | (6) |
| | b) What do you meant by turbo charging and supercharging? | (4) |
| 7 | A single cylinder 4 stroke engine was tested and following observations were noted. Area of indicator diagram = 3 cm ² . Length of indicator diagram = 4 cm. Indicator spring constant is 10 bar/cm. Speed of the engine is 400 rpm. Brake drum diameter = 120 cm. Dead weight on brake = 380 N. Spring balance reading is 50 N. Fuel consumption rate is 2.8 kg/hr and calorific value of the fuel is 42000 kJ/kg. Bore is 16 cm and stroke is 20 cm. Find frictional power, | (10) |

mechanical efficiency, specific fuel consumption and brake thermal efficiency.

- 8 a) Write short notes on (i) LPG (ii) CNG (iii) Biogas (6)
b) Define equivalence ratio and explain its significance. (4)

PART C

Answer any four full questions, each carries 10marks.

- 9 a) How catalytic converter helps to reduce emission of an engine? (6)
b) Explain about Octane and Cetane rating of fuels. (4)
- 10 With the help of a pressure – crank angle diagram explain different stages of CI engine combustion. (10)
- 11 Explain detonation in SI engine with the help of auto ignition theory. What are the factors effecting detonation? Also mention various effects caused by detonation. (10)
- 12 a) Differentiate between open cycle gas turbine and closed cycle gas turbine. (4)
b) Derive the expression for optimum pressure ratio for maximum work output. (6)
- 13 Air enters an open cycle gas turbine plant at 1 bar and 30 °C. The pressure ratio of the plant is 5.6. Compression is carried out in two stages with perfect intercooling in between. Maximum temperature of the cycle is limited to 700 °C. Isentropic efficiency of both the compressors are 85% and that of turbine is 90%. Air flow rate is 1.2 kg/S. Determine the power developed and efficiency of the plant. $C_p = 1.02 \text{ kJ/kgK}$ and $\gamma = 1.41$ for both air and gas. Mass of fuel can be neglected. (10)
- 14 With the help of T-S diagrams explain how intercooling, reheating and regeneration improve the performance of gas turbine cycle. (10)

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Fourth semester B.Tech examinations (S), September 2020

Course Code: ME204**Course Name: THERMAL ENGINEERING**

Max. Marks: 100

Duration: 3 Hours

*Use of steam table is permitted.
Missing data if any, may be suitably assumed*

PART A

Answer any three questions. Each question carries 10 marks.

- 1 a) With a schematic, explain working of any one safety valve employed as a boiler mounting. 5
- b) What do you mean by the term 'Choking' in connection with flow through a steam nozzle? Illustrate the phenomena with the help of mass flow rate vs pressure ratio diagram. 5
- 2 a) Draw representative schematic of subsonic and supersonic nozzle. Under what conditions, a convergent-divergent duct behaves as a nozzle? 5
- b) Steam at an absolute pressure of 10 bar and 250°C expands isentropically in a steam turbine till the pressure drops to 1 bar. Estimate the quality of steam leaving the turbine and work developed per kg of steam. If the actual drop is 90% of isentropic enthalpy drop, and steam flow through the turbine is 500 kg/min, determine the power developed by the turbine. Use Mollier chart. 5
- 3 a) Draw blading diagram for a two-row Curtis stage (ie, velocity compounded stage) followed by two reaction stages and plot pressure and velocity variation in axial direction. 5
- b) Draw Combined Velocity diagram of a Parsons Reaction Turbine operating under maximum blading efficiency condition. Show blade angles, absolute and relative velocity components on the diagram. How can you evaluate axial thrust developed by this reaction stage? 5
- 4 a) A four stage steam turbine receives steam at 35 bar and 435°C and exhausts at 0.04 bar. Each stage has same efficiency ratio of 0.76. If the pressure at the end of stages are 5, 1.2 and 0.25 bar respectively, determine (i) Rankine enthalpy drop, (ii) Work done and (iii) Reheat factor. 10

PART B

Answer any three questions. Each question carries 10 marks

- 5 a) Define dissociation. Discuss the effect of dissociation on power developed by an Otto cycle with neat sketches. 5
- b) Discuss the purpose of supercharging with a neat schematic of a supercharged engine. 5
- 6 a) Define: (i) Brake power, (ii) Indicated power, (iii) Specific fuel consumption (iv) Volumetric efficiency and (v) Calorific value 5
- b) Discuss the effect of dopes and additives on performance of IC engines. 5
- 7 a) Explain the working of a Stirling engine with the support of thermodynamic cycle on p-v diagram. 5
- b) With a neat sketch, explain the method of flue gas analysis using an Orsat apparatus. 5
- 8 a) The compression ratio of an engine working on Otto cycle is 6 and A:F ratio of the mixture is 15. The Calorific value of the fuel used is 44 MJ/kg. The pressure and temperature of the mixture at the beginning of compression are 1 bar and 60°C. Determine the maximum pressure in the cylinder if the compression follows the law $p v^{1.32} = \text{Constant}$. Specific heat value is given by, $C_v = 0.71 + (0.0002 * T)$ kJ/kg K, where T is in K. 10

PART C

Answer any four questions. Each question carries 10 marks.

- 9 a) Differentiate between knock and pre-ignition. 5
- b) Write a short note on how Catalytic convertor reduces emission of hydrocarbons and carbon monoxide. 5
- 10 a) What are the stages of combustion in a SI engine? Explain with the support of pressure vs crank angle diagram. 5
- b) Define highest useful compression ratio (HUCR) and Octane Number for an SI engine fuel. How it is evaluated? 5
- 11 a) Explain with a neat sketch, Annular combustion chamber of a gas turbine plant. 5
- b) Explain the effect of regeneration on gas turbine plant output and efficiency. 5
- 12 a) Define Swirl, Tumble and Squish. Explain how various types of CI engine combustion chamber is designed to produce swirl, with suitable diagrams. 10
- 13 a) Derive an expression for air standard efficiency of a constant pressure gas turbine cycle in terms of pressure ratio. State your assumptions. Discuss the effect of pressure ratio on cycle output and efficiency. 10

- 14 a) The pressure ratio of a regenerative air standard gas turbine cycle is 5. Air enters the compressor at 1 bar and 300 K and leaves at 490 K. The maximum temperature in the cycle is 1000 K. Calculate the cycle efficiency, given that the efficiency of regenerator and adiabatic efficiency of turbine are each 80 %. Draw T-s diagram. 10