F 4906 (Pages : 2) Reg. No.....

Name.....

# B.TECH. DEGREE EXAMINATION, NOVEMBER 2015

## Fifth Semester

Branch : Mechanical Engineering/Automobile Engineering

ME 010 505/AU 010 505—I.C. ENGINES AND COMBUSTION (ME, AU)

(New Scheme–2010 Admission onwards)

[Regular/Improvement/Supplementary]

Time : Three Hours Maximum : 100 Marks

## Part A

*Answer* **all** *questions.*
*Each question carries* 3 *marks.*

1. How can we reverse a heavy duty two-stroke diesel engine ?
2. Calculate the stoichiometric air fuel ratio for Methanol.
3. How we will fix the percentage of cooled EGR in a high speed Diesel engine ?
4. Compare the engine performance parameters of GDI and MPFI engines.
5. Explain the conditions favouring excessive NOx formation from a diesel engine.

(5 × 3 = 15 marks)

## Part B

*Answer* **all** *questions.*
*Each question carries* 5 *marks.*

6. Explain the working of CDI system with a diagram.
7. What is a UPCR ? What are its advantages over CRDi ?
8. What are TSI engines ? How it works ? Give an example.
9. What is the difference between Swirl, Squish and Tumble ?
10. Compare and distinguish between Diesel knock and Detonation.

(5 × 5 = 25 marks)

**Turn over**

## Part C

*Answer* **all** *questions.*
*Each full question carries* 12 *marks.*

11. (a) Write brief comparison of S.I. engines and Super charged S.I. engines.

    (b) Discuss the effect of cetane number of a fuel on C.I. engine combustion.

*Or*

12. (a) Explain, how the cetane number of a fuel can be determined.

    (b) With a suitable sketch, explain the working of a Wankel engine.

13. Explain the Air fuel ratio requirement for the following conditions in an S.I. engine.

    (a) Idling ; (b) Slow speed and part load ; (c) Acceleration ; (d) Cruising.

*Or*

14. Explain and mark the position of various sensors and actuators used in a modern MPFI engine with the help of a suitable layout diagram.

15. (a) How can we calculate the air fuel ratio from the exhaust gas composition ?

    (b) Discuss the effect of dissociation on combustion pressure, power loss and emission.

*Or*

16. Explain the working of an electric supercharger with a diagram.

17. Describe the various factors affecting the combustion process in a CI engine.

*Or*

18. Explain the process of Detonation in an S.I. engine. How can we control Detonation ?

19. What are the different pollutants from a C.I. engine ? Discuss the working a DPF used in modern diesel cars.

*Or*

20. (a) What is a Morse test and why we conduct it ? Can we conduct it for a Diesel engine ?

    (b) Discuss the principle of working of a Diesel smoke meter.

(5 × 12 = 60 marks)

F 4891 (Pages : 2) Reg. No.....

Name.....

# B.TECH. DEGREE EXAMINATION, NOVEMBER 2015

## Fifth Semester

Branch : Automobile Engineering/Mechanical Engineering

AU 010 504/ME 010 504—KINEMATICS OF MACHINERY (AU, ME)

(New Scheme—2010 Admission onwards)

[Regular/Improvement/Supplementary]

Time : Three Hours Maximum : 100 Marks

## Part A

*Answer* **all** *questions.*
*Each question carries* 3 *marks.*

1. What do you understand by the terms Machine and mechanism ? How these differ from each other ?
2. Define the term apparent acceleration.
3. What do you mean by negative *dof* and zero *dof* for a mechanism ?
4. What do you mean by pressure angle of a cam ? What is its significance ?
5. What is the significance of contact ratio in gear drive ?

(5 × 3 = 15 marks)

## Part B

*Answer* **all** *questions.*
*Each full question carries* 5 *marks.*

6. Explain the Grubler's criterion for plane mechanism to obtain the degree of freedom.
7. Explain the procedure for locating instantaneous centers on a mechanism.
8. How will you classify a four bar mechanism according to Grashof's Criterion of movability ?
9. Describe the various factors that determines the size of base circle of a cam.
10. Explain various preventive measures to avoid interference between gears.

(5 × 5 = 25 marks)

## Part C

*Answer* **all** *questions.*
*Each question carries* 12 *marks.*

11. Use the mobility criterion to find out a planner mechanism containing a moving quaternary link. How many distinct variations of this mechanism can you find ?

*Or*

**Turn over**

12. The lengths of a planner four bar linkage are 25, 75, 125 and 125 mm. Assemble the links in all possible combinations and sketch the four inversions of each. Do these linkages satisfy Grashof's law ?

13. The position vector of a point is given by the equation $R = 2.5\ e^{j\pi t}$ where, R is in meters. Find the velocity of the point at $t = 0.40\ s$.

*Or*

14. Explain Coriolis component of acceleration and derive an expression for it. Draw its possible directions.

15. Give a comparison of analytical and graphical three position synthesis with a suitable example.

*Or*

16. The dimensions of a four bar mechanism are 100 mm, 400 mm, 700 mm and 800 mm. Draw the inversions of the mechanism and decide their movability.

17. For a full rise SHM, write the equations for the velocity and the jerk at the midpoint of the motion. Also determine the acceleration at the beginning and end of motion.

*Or*

18. A plate cam rotates at 300 rev/min and drives a reciprocating radial roller follower for a full rise of 75 mm in of cam rotation. Find the minimum radius of the prime circle if simple harmonic motion is used and the pressure angle is not to exceed 25°.

    Find the maximum acceleration of the follower.

19. What is the main limitation of a helical gear ? Explain with the help of a neat sketch, how that limitation can be overcome in herringbone gear.

*Or*

20. Two mating gears have 20 and 40 involute teeth of module 10 mm and 20° pressure angle. If the addendum on each wheel is such that the path of contact is maximum and interference is just avoided, find the path of contact, arc of contact and contact ratio. Also find the addendum for each gear.

(5 × 12 = 60 marks)

F 4885 (Pages : 2) Reg. No.....

Name.....

# B.TECH. DEGREE EXAMINATION, NOVEMBER 2015

## Fifth Semester

Branch : Mechanical Engineering/Production Engineering

ME 010 503/ PE 010 503—ADVANCED MECHANICS OF MATERIALS (ME, PE)

(New Scheme—2010 Admission onwards)

[Regular/Improvement/Supplementary]

Time : Three Hours Maximum : 100 Marks

## Part A

*Answer* **all** *questions. Each question carries* 3 *marks.*

1. Explain the terms principal stress and principal plane.
2. What is Saint Venant's principle for end effects ?
3. Discuss the minimum potential energy theorem.
4. Write down torsional equation for a shaft subjected to twisting moment. What are the assumptions ?
5. What is meant by unsymmetrical bending of a beam ? Write few examples.

(5 × 3 = 15 marks)

## Part B

*Answer* **all** *questions. Each question carries* 5 *marks.*

6. State Hooks law and write the generalized Hooks law for a 3D stress condition.
7. Explain thick cylinders and sketch the distribution of hoop stress and radial pressure across its section when subjected to external pressure.
8. What do you mean by shear centre and stress concentration ?
9. State and explain Castigliano's first and second theorem.
10. State Airy's stress function.

(5 × 5 = 25 marks)

## Part C

*Answer* **all** *questions. Each question carries* 12 *marks.*

11. A rectangular bar of cross-sectional area 10000 $mm^2$ is subjected to an axial load of 20 kN. Determine the normal and shear stresses on a section which is inclined at an angle of 30° with normal cross-section of the bar.

*Or*

12. Find the diameter of a circular bar which is subjected to an axial pull of 160 kN, if the maximum allowable shear stress on any section is 65 N / $mm^2$.

**Turn over**

13. Explain the compatibility conditions. List out its significances.

*Or*

14. A square beam 20 mm × 20 mm in section and 2 m long is supported at the ends. The beam fails when a point load of 400 N is applied at the centre of the beam. What uniformly distributed load per metre length will break a cantilever of the same material 40 mm wide, 60 mm deep and 3 m long.

15. A cantilever of length 1 m carries a point load of 2000 N at the free end. The cross-section of the cantilever is an unequal angle of dimensions 100 mm by 60 mm and 10 mm thick. The small leg of angle (i.e., 60 mm) is horizontal. The load passes through the centroid of the cross-section. Determine :

    (i) Position of neutral axis.

    (ii) The magnitude of maximum stress setup, at the fixed section of the cantilever.

*Or*

16. Determine the maximum and minimum hoop stress across the section of a pipe of 400 mm internal diameter and 100 mm thick, when the pipe contains a fluid at a pressure of 8 N / mm$^2$. Also sketch the radial pressure distribution and hoop stress distribution across the section.

17. Explain the Maxwell reciprocal theorem and Strain energy deformation.

*Or*

18. The stress field for a beam of length $2l$ and depth $2c$ under the bending moment M is given by $\sigma_x = -3M/2c^3\ y$, $\sigma_y = \sigma_z = \tau_{xy} = \tau_{yz} = \tau_{zx} = 0$. Find the total strain energy density in the beam.

19. Derive the expression for the torsion of hollow circular shaft.

*Or*

20. Determine the shear stress induced and the angle of twist per unit length of a hollow shaft of dimension 80 mm × 40 mm and wall thickness 5 mm when subjected to a torque of 1 kN-m, $G = 1.3 \times 10^4$ MPa.

(5 × 12 = 60 marks)

F 4867 3

(Pages : 2) Reg. No.....

Name.....

# B.TECH. DEGREE EXAMINATION, NOVEMBER 2015

**Fifth Semester**

Branch : Automobile Engineering / Mechanical Engineering

AU 010 502 / ME 010 502 – COMPUTER AIDED DESIGN AND MANUFACTURING (AU, ME)

(New Scheme – 2010 Admission onwards)

[Regular/Improvement/Supplementary]

Time : Three Hours Maximum : 100 Marks

## Part A

*Answer* **all** *questions.*

*Each question carries* 3 *marks.*

1. What are the storage devices in CAD?
2. Differentiate wireframe and solid modelling.
3. What is manual programming?
4. Define process planning.
5. What are the components of a robot?

(5 × 3 = 15 marks)

## Part B

*Answer* **all** *questions.*

*Each question carries* 5 *marks.*

6. Explain Bresenham's circle drawing algorithm.
7. Write a note on CNC languages.
8. What arc the advantages and disadvantages of numerical control?
9. Explain types of flexible manufacturing systems.
10. Explain the role of actuators in robotics.

(5 × 5 = 25 marks)

## Part C

*Answer* **all** *questions.*

*Each full question carries* 12 *marks.*

11. Explain translation, rotation, reflection and scaling with relevant matrices.

*Or*

12. Trace the line drawing from (10, 10) to (20, 20) using DDA line algorithm.

Turn over

13. Explain the classification of numeric control with merits and demerits of each.

*Or*

14. What are Programmable logic arrays? Explain how they are used in CAD.

15. Explain with example, the geometry commands and motion commands.

*Or*

16. What is part programming? Explain how it is different from other programming?

17. Explain the structure of variant and generative process planning methods.

*Or*

18. Explain the concept of FMS. Why are they important?

19. Briefly explain the basic components and their functions used in robots.

*Or*

20. With relevant theoretical concepts, explain robot arm dynamics.

[5 × 12 = 60 marks]

F 4854 (Pages : 2) Reg. No.....

Name.....

# B.TECH. DEGREE EXAMINATION, NOVEMBER 2015

**Fifth Semester**

Branch : Mechanical Engineering/Automobile Engineering

THERMAL ENGINEERING—I (M, U)

(Old Scheme—Prior to 2010 Admissions)

[Supplementary/Mercy Chance]

Time : Three Hours Maximum : 100 Marks

*Use of Mollier diagram and Steam tables are permitted.*

## Part A

*Answer* **all** *questions.*
*Each question carries* 4 *marks.*

1. Write a note on "heat rate" and 'steam rate'.
2. Draw the T-s diagram of the ideal regenerative cycle.
3. How will you evaluate the performance of a steam nozzle ?
4. List the advantages of steam turbine over steam engines.
5. Write a note on thermodynamic scale.
6. Write a note on combustion intensity.
7. Define efficiency of a solar collector.
8. Discuss optical losses in solar collector.
9. List the salient features of cooling ponds.
10. What are steam condensers ?

(10 × 4 = 40 marks)

## Part B

*Answer* **all** *questions.*
*Each question carries* 12 *marks.*

11. What are modern steam generators ? Draw neat sketches to explain the mechanism of working.

*Or*

12. In a steam power plant the condition of steam at inlet to the steam generator is 20 bar and 300° C. and the condenser pressure is 0.1 bar. Two feed water heaters operate at optimum temperatures. Determine (a) the quality of steam at turbine exhaust, (b) net-work per kg. of steam, (c) cycle efficiency, and (d) the steam rate. Neglect pump work.

**Turn over**

13. A 10,000 kW steam turbine operates with steam at the inlet at 40 bar, 400° C. and exhausts at 0.1 bar, 10,000 kg./h of steam at 3 bar are to be extracted for process work. The turbine has 75 % isentropic efficiency throughout. Find the boiler capacity required.

*Or*

14. Derive expressions for work done and efficiencies in a steam turbine. Draw velocity triangles to explain its principle.

15. A simple gas turbine plant operating on Brayton cycle has air inlet temperature 27° C., pressure ratio 9, and maximum cycle temperature 727° C. What will be the improvement in cycle efficiency and output if the turbine process is divided into two stages each of pressure ratio 3, with intermediate reheating to 727° C.

*Or*

16. Derive an expression for specific work output of a gas turbine unit in terms of pressure ratio, isentropic efficiencies of compressor and turbine and the maximum and minimum temperatures, $T_3$ and $T_1$.

17. Explain in detail :

    (i) Focussing type solar collector. (4 marks)

    (ii) Solar concentrator. (4 marks)

    (iii) Sun tracking system. (4 marks)

*Or*

18. Discuss the aspects of solar-based heating technologies. With a flow chart, explain the transfer of thermal energy in the systems.

19. Explain the layout and working of a steam power plant. Explain each component in the power plant.

*Or*

20. Derive expression for overall efficiency of a steam power plant. Discuss the losses in the steam power plant.

[5 × 12 = 60 marks]

F 4846 (Pages : 2) Reg. No.....

Name.....

# B.TECH. DEGREE EXAMINATION, NOVEMBER 2015

## Fifth Semester

Branch : Mechanical Engineering/Automobile Engineering

MECHATRONICS AND CONTROL SYSTEMS (M, U)

(Old Scheme—Prior to 2010 Admissions)

[Supplementary/Mercy Chance]

Time : Three Hours Maximum : 100 Marks

## Part A

*Answer* **all** *questions.*
*Each question carries* 4 *marks.*

1. Identify the sensor, signal conditioner and display elements in the measurement system of a Bourden pressure gauge.
2. Explain how potentiometer sensors can be used to measure displacement.
3. What is token passing method of network access control ?
4. Why interfacing circuitry is required in the case of microprocessor based systems ?
5. What are the properties of a linear system ?
6. Describe a practical closed loop system and an open loop control system.
7. What do you mean by the steady state error ? Derive its expression for a unity feedback system.
8. Explain how real and imaginary parts influence system response.
9. Explain how Routh array is constructed.
10. Describe how relative stability is found using frequency response.

(10 × 4 = 40 marks)

## Part B

*Answer* **all** *questions.*
*Each full question carries* 12 *marks.*

11. What are the key elements of mechatronics ? Give one example of a mechatronics system.

*Or*

12. Explain operational amplifiers. Describe the operation of an inverting amplifier with necessary circuit diagrams.
13. What are analog and digital signals ? Explain methods for analog to digital conversion.

*Or*

14. Explain the working of the following : (a) DVD ROM ; and (b) Printers.

**Turn over**

15. For a series RLC circuit excited from a voltage source, V ($t$), if the output is the voltage across the capacitor, $V_c$ ($t$), find the transfer function.

*Or*

16. Derive the transfer function of field controlled d.c. servo motor.

17. Find the unit step response of a system with transfer function $G(s) = \frac{1}{s^2 + 0.8s + 1}$. Also find its rise time, peak time peak overshoot and settling time.

*Or*

18. Given a unity feedback system with open loop transfer function $G(s) = \frac{1}{2s^4 + 5s^3 + s^2 + 2s}$, using Routh Hurwitz criterion check whether the closed loop system is stable.

19. Using Nyquist stability criterion, investigate the closed loop stability of a negative feedback control system whose over loop transfer function is given by :

$$G(s)\,H(s) = \frac{6}{(s^2 + 2s + 2)(s + 2)}.$$

*Or*

20. Sketch the bode plot for a negative feedback control system whose open-loop transfer function is given by $G(s)\,H(s) = \frac{s + 3}{s(s + 1)(s + 2)}$.

(5 × 12 = 60 marks)

F 4835 \ 55 (Pages : 2) Reg. No.....

Name.....

# B.TECH. DEGREE EXAMINATION, NOVEMBER 2015

**Fifth Semester**

Branch : Mechanical Engineering

THEORY OF MACHINES—II (M)

(Old Scheme—Prior to 2010 Admissions)

[Supplementary/Mercy Chance]

Time : Three Hours Maximum : 100 Marks

## Part A

*Answer* **all** *questions.*
*Each question carries* 4 *marks.*

1. Briefly discuss the concept of force couple.
2. What are inertia forces ?
3. Draw the torque-speed characteristics of an engine.
4. Distinguish between effort and power.
5. Define coefficient of fluctuation of energy.
6. Discuss Crank pin effort.
7. Write the principle of a gyroscope.
8. Write a note on gear trains.
9. Discuss cycloidal motion.
10. List the procedure to draw cam profile.

(10 × 4 = 40 marks)

## Part B

*Answer* **all** *questions.*
*Each full question carries* 12 *marks.*

11. Discuss with neat sketches :
    (i) Analysis of four bar mechanism.
    (ii) Dynamic force analysis of slider crank mechanism.

*Or*

**Turn over**

12. The crank radius and connecting rod length of a reciprocating engine running at 300 r.p.m., is 25 cm. and 100 cm. respectively. Determine :

    (i) The crank angle for maximum piston velocity.

    (ii) Crank angle for zero acceleration of piston.

13. Distinguish carefully between the functions of (a) flywheel and (b) a governor of an engine. Describe in detail.

*Or*

14. In a spring controlled governor, the curve of controlling force is a straight line. When the balls are 35 cm. apart, the controlling force is 1290 N and when 20 cm. apart the same is 600 N. Determine (a) the speed at which governor runs with balls 25 cm. apart. Determine (b) initial tension on the spring. Each ball has a mass of 10 kg.

15. A mass of flywheel of a steam engine is 2000 kg. and has got a radius of gyration of 76 cm. The starting torque of steam engine is 1300 N-m and may be assumed constant. Determine the angular acceleration of flywheel along with speed and kinetic energy after 10s.

*Or*

16. What is turning moment diagram ? Draw the turning moment diagram for (i) steam engine ; (ii) IC engine.

17. Explain the gyroscopic effects on four wheeled vehicles. Discuss in detail.

*Or*

18. Draw neat sketches to explain gear trains. Discuss on simple, compound and epicyclic gear trains. Derive the necessary equations. Give practical applications.

19. Draw the profile of a cam to give the following motion to a roller follower :

    (i) Outstroke during 60° of cam rotation.

    (ii) Dwell for 10° cam rotation.

    (iii) Return stroke during 60° of cam rotation.

    (iv) Dwell for the remaining 230° of cam rotation.

*Or*

20. Explain with the help of displacement, velocity and acceleration diagrams, a uniform acceleration and uniform retardation profile cam.

(5 × 12 = 60 marks)

F 4825

(Pages : 2)

Reg. No.....

Name.....

# B.TECH. DEGREE EXAMINATION, NOVEMBER 2015

**Fifth Semester**

Branch : Mechanical Engineering/Automobile Engineering

COMPUTER PROGRAMMING (M, U)

(Old Scheme—Prior to 2010 Admissions)

[Supplementary/Mercy Chance]

Time : Three Hours

Maximum : 100 Marks

*Write neat and efficient C programs wherever needed.*

## Part A

*Answer* **all** *questions.*
*Each question carries* 4 *marks.*

1. Describe the bitwise operators in C and state their precedence relationship.
2. Write a C program to print a line of 40 asteriks using "for" loop.
3. What are the differences between arrays and structures ?
4. Show two-dimensional array initialisation, declaration, subscripting and usage in C with the help of example.
5. Define recursion. Mention the advantage of its usage.
6. How an array name is interpreted when it is passed to a function ? Explain with an example.
7. Define a pointer. How is a pointer variable initiliazed ?
8. What are the differences between the malloc and calloc functions ?
9. How command line parameters are used in C ?
10. What are the three steps that are followed while accessing a file ? Explain.

(10 × 4 = 40 marks)

## Part B

*Answer* **all** *questions.*
*Each full question carries* 12 *marks.*

11. Write all the operators in C and explain their precedence and associativity with suitable examples.

*Or*

12. Write a C program to find the sum of the series $1-\frac{x^2}{2!}+\frac{x^4}{4!}-\frac{x^6}{6!}+\ldots,$

**Turn over**

13. Write a C program to sort a set of mark sheets in '*n*' students. The marksheet consists of the name, register number, marks of 8 subjects and total marks. Make use of a structure to develop the program.

*Or*

14. Write a C program to read an M × N matrix and print its transpose.

15. Write a function to accept 20 characters and display whether each input character is a digit, a lower-case alphabet, an upper-case alphabet or a symbol.

*Or*

16. Write a function to find the number of thousands, five-hundreds, hundreds, fifties, twenties, tens, fives, twos and ones (currencies) in a given amount.

17. Write a C program using pointers to count the characters and words in a text file.

*Or*

18. Write a C program to create a single linked list to read a set of N numbers and print the list.

19. Two files A and B contain sorted list of integers. Write a program to produce a third file C which holds a single sorted, merged list of these two files. Use command line arguments to specify the file names.

*Or*

20. Write a C progrm to reverse the contents of a text file.

(5 × 12 = 60 marks)

F 4866 (Pages : 2) Reg. No.....

Name.....

# B.TECH. DEGREE EXAMINATION, NOVEMBER 2015

**Fifth Semester**

Branch : Aeronautical Engineering/Computer Science and Engineering/Electrical and Electronics Engineering

EN 010 502 – PRINCIPLES OF MANAGEMENT (AN, CS, EE)

(New Scheme – 2010 Admission onwards)

[Regular/Improvement/Supplementary]

Time : Three Hours Maximum : 100 Marks

## Part A

*Answer* **all** *questions.*

*Each question carries* 3 *marks.*

1. What is Span of Control?
2. What is quality circle?
3. What is production and what are its objective?
4. State the importance of Cost Management.
5. What is Sales Forecasting?

(5 × 3 = 15 marks)

## Part B

*Answer* **all** *questions.*

*Each question carries* 5 *marks.*

6. Explain Authority and Responsibility.
7. Explain the concept of Personnel Management highlighting its aims and objectives.
8. Explain Product life-cycle.
9. Explain the importance and types of capital.
10. Explain modern concept of marketing.

(5 × 5 = 25 marks)

## Part C

*Answer* **all** *questions.*

*Each question carries* 12 *marks.*

11. (a) Explain scientific management highlighting the contributions of Taylor and Gilberth.

*Or*

(b) Explain any *five* functions of management in detail.

**Turn over**

12. (a) Explain Man power planning in detail.

*Or*

(b) Explain the relevance and functions of Trade Unions.

13. (a) Explain with an example how project planning is done with PERT.

*Or*

(b) Explain the functions of Production Management in detail.

14. (a) Explain various elements of cost.

*Or*

(b) Explain how selling price of a product is calculated ? What are the factors influencing the selling price.

15. (a) Explain Sales promotion.

*Or*

(b) Explain Marketing Research.

(5 × 12 = 60 marks)

F 4919 (Pages : 2) Reg. No.....

Name.....

# B.TECH. DEGREE EXAMINATION, NOVEMBER 2015

## Fifth Semester

Branch : Mechanical Engineering / Automobile Engineering

ME 010 506 / AU 010 506—THERMODYNAMICS (ME, AU)

(New Scheme—2010 Admission onwards)

[Regular/Improvement/Supplementary]

Time : Three Hours Maximum : 100 Marks

*Use of Steam tables and Psychometric chart are permitted.*

## Part A

*Answer* **all** *questions.*
*Each question carries* 3 *marks.*

1. What is the 'two-property rule' ?
2. What is caloric theory of heat ? Why was it rejected ?
3. Derive a relation between COP of a heat pump and COP of a refrigerator.
4. What is inversion temperature ?
5. What do you understand by triple point ?

(5 × 3 = 15 marks)

## Part B

*Answer* **all** *questions.*
*Each question carries* 5 *marks.*

6. An open system defined for a fixed region and a control volume are synonymous. Explain.
7. Show that energy is a property of system.
8. What are the different types of irreversibility ?
9. What is the value of the Clapeyron equation in thermodynamics ?
10. Explain the terms critical pressure, critical temperature, critical volume of water.

(5 × 5 = 25 marks)

## Part C

*Answer* **all** *questions.*
*Each full question carries* 12 *marks.*

11. A 1-$m^3$ tank contains 2.841 kg of steam at 0.6 MPa. Determine the temperature of the steam, using (a) the ideal gas equation ; (b) the van der Waals equation ; and (c) the steam tables.

*Or*

12. (a) What is the physical significance of the compressibility factor Z ?

    (b) How are the reduced pressure and reduced temperature defined ?

**Turn over**

13. During one cycle the working fluid in an engine engages in two work interactions : 15 kJ to the fluid and 44 kJ from the fluid, and three heat interactions, two of which are known : 75 kJ to the fluid and 40 kJ from the fluid. Evaluate the magnitude and direction of the third heat transfer.

*Or*

14. Explain Joule-Thompson effect. Define Joule-Thompson coefficient. Derive a relation for the same.

15. A reversible heat engine operates between two reservoirs at temperature of 600° C and 40° C. The engine drives a reversible refrigerator which operates between reservoirs at temperature of 40° C and –20° C. The heat transfer to the heat engine is 2000 kJ and net work output of the combined engine refrigerator plant is 360 kJ.

    (i) Evaluate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40° C.

    (ii) Re-consider (i) given that the efficiency of the heat engine and the COP of the refrigerator are each 40% of their maximum possible values.

*Or*

16. What is Clausius inequality ? Demonstrate the validity of Clausius inequality.

17. Derive the Maxwell Equations.

*Or*

18. Derive the general relations for entropy change of a simple compressible system.

19. The dry- and wet-bulb temperatures of atmospheric air at 95 kPa are 25 and 17° C, respectively. Determine (i) the specific humidity ; (ii) the relative humidity ; and (iii) the enthalpy of the air, in kJ/kg dry air.

*Or*

20. Two airstreams are mixed steadily and adiabatically. The first stream enters at 32° C and 40 per cent relative humidity at a rate of 20 $m^3$/min while the second stream enters at 12° C and 90 per cent relative humidity at a rate of 25 $m^3$/min. Assuming that the mixing process occurs at a pressure of 1 atm, determine the specific humidity, the relative humidity, the dry-bulb temperature and the volume flow rate of the mixture.

(5 × 12 = 60 marks)