

MECHANICAL ENGINEERING

Paper : II

TES Grade V(A)

Full Marks – 200

Time – Three hours

The figures in the margin indicate full marks for the questions.

Candidates are required to give their answers in their own words as far as practicable.

GROUP-A

15×6 = 90

Answer *all* the questions.

Each question carries six marks.

1. Define Quasi-static process. What are the limitations of first law of thermodynamics ?
4+2=6
2. Write 'Kelvin-Planck statement' of second law of thermodynamics. Define 'Entropy'.
4+2=6
3. Give a brief account of emissions from CI engines.
6
4. What is an air cooling system and in which type of engines it is normally used ?
4+2=6

[Turn over

5. Draw otto, diesel and dual cycle on a P-V and a T-S diagram to compare them for the same compression ratio and heat input. 6
6. What is the basic equation for steady state heat conduction ? What are the assumptions for this equation ? 1+5=6
7. In case of radiation, define absorptivity, transmissivity and reflectivity. What is the relation among them ? $4\frac{1}{2}+1\frac{1}{2}=6$
8. Define 'cop of heating' and 'cop of cooling'. Establish relation between these two. 2+2+2=6
9. Briefly explain the effect of superheating in case of vapour compression refrigeration cycle. 6
10. Define Relative humidity. What are the various processes involved in air conditioning to vary the psychometric properties of air according to requirement ? 2+4=6
11. What are the various heat treatment processes of steel ? What is the percentage of carbon in case of mild steel and high carbon steel ? 4+2=6
12. Differentiate between 'Production' and 'Productivity'. 6
13. What are the principles of Materials Handling ? 6

14. Briefly explain ABC analysis in inventory control. 6

15. What are the steps in CPM project planning in case of network analysis ? 6

GROUP-B

40×2=80

Answer *all* questions.

Each question carries *two* marks.

Choose the correct answer from the alternatives of the following :

1. Tripple point temperature and pressure for water are

(a) 100°C and 1 ata

(b) 0°C and 1 ata

(c) 0.1°C and 0.06028 ata

(d) 0.1°C and 0.006028 ata

2. The critical pressure ratio for a steam nozzle is given by

(a) $r = \left(\frac{2}{n+1} \right)^{\frac{n}{n-1}}$

(b) $r = \left(\frac{2}{n+1} \right)^{\frac{n}{n-1}}$

(c) $r = \left(\frac{2}{n+1} \right)^{\frac{n}{n-1}}$

(d) $r = \left(\frac{2}{n+1} \right)^{\frac{n}{n-1}}$

4/TR/TES/M-II/V(A)/13

(3)

[Turn over

3. The optimum intermediate pressure in case of two stage compression is given by

(a) $p_2 = \frac{p_1 + p_3}{2}$

(b) $p_2 = \sqrt{p_1 p_3}$

(c) $p_2 = p_1 + \sqrt{p_1^2 p_3^2}$

(d) $p_2 = \sqrt{\frac{p_1^2 p_3^2}{2}}$

4. In the polytropic process equation $pv^n = \text{constant}$, if the value of n is infinitely large, the process is termed as

(a) Constant volume

(b) Constant pressure

(c) Constant temperature

(d) Adiabatic

5. Flash point for diesel fuel oil should be

(a) Minimum 49°C

(b) Maximum 49°C

(c) Minimum 100°C

(d) Maximum 100°C

6. Highest useful compression ratio is the compression ratio at which

(a) an engine can be safely operated

(b) an engine gives maximum thermal efficiency

(c) detonation first becomes audible

(d) an engine operates smoothly

7. A fusible plug is fitted in small boilers in order to
- (a) avoid excessive build up of pressure
 - (b) avoid explosion
 - (c) extinguish fire if water level in the boiler falls below alarming limit
 - (d) remove molten ash
8. Thermal efficiency of C.I engines on weak mixtures is
- (a) Higher
 - (b) Lower
 - (c) Unaffected
 - (d) None of the above
9. An isolated system
- (a) Is a specified region where transfers of energy and or mass takes place
 - (b) Is a region of constant mass and only energy is allowed to cross the boundaries
 - (c) Can not transfer either energy or mass to or from the surroundings
 - (d) Is one in which mass within the system is not necessarily constant.

10. When a bicycle pump is operated slowly the process of compression will be nearly

- (a) Isothermal process
- (b) Constant volume process
- (c) Constant pressure process
- (d) Throttling process

11. If R_1 and R_2 are the inner and outer radii of a cylinder, the heat conduction through a cylinder is proportional to

- (a) $(R_2 - R_1)$
- (b) $R_1 \times R_2$
- (c) $\log_e \left(\frac{R_1}{R_2} \right)$
- (d) $\frac{1}{\log_e \left(\frac{R_1}{R_2} \right)}$

12. There are two spheres of copper, the ratio of their radii being 1:3 both at the same temperature. The ratio of heat contents will be

- (a) 1:1
- (b) 1:9
- (c) 1:27
- (d) 1:81

13. For all substances the absorptivity must lie between

- (a) 0 and 0.1
- (b) -1 and +1
- (c) 0 and +0.5
- (d) 0 and 1

14. Kinematic viscosity indicates

- (a) momentum transport by molecular friction
- (b) heat energy transport through conduction
- (c) heat energy transport through convection
- (d) conversion of momentum into heat energy

15. A body cools from 90°C to 80°C in 5 minutes. Under the same external conditions to cool from 80°C to 70°C body will take

- (a) 5 minutes
- (b) less than 5 minutes
- (c) more than 5 minutes
- (d) can not be predicted

16. The ratio of heat transfer coefficient to the flow of heat per unit temperature rise due to the velocity of the fluid is known as

- (a) Prandtl Number
- (b) Grashoff Number
- (c) Stanton Number
- (d) Weber Number

17. A high value of Prandtl Number indicates

- (a) rapid diffusion of momentum by viscous action compared to diffusion of energy
- (b) relative heat transfer by conduction to convection
- (c) rapid heat transfer by forced convection to natural convection
- (d) None of the above

18. For the radiation between two infinite parallel planes of emissivity ϵ_1 and ϵ_2 , the emissivity factor is given

(a) $\epsilon_1 \epsilon_2$ (b) $\frac{1}{\epsilon_1} + \frac{1}{\epsilon_2}$

(c) $\frac{1}{\frac{1}{\epsilon_1} + \frac{1}{\epsilon_2} - 1}$ (d) $\frac{1}{\frac{1}{\epsilon_1} + \frac{1}{\epsilon_2} + 1}$

19. In vapour compression cycle the highest temperature of the refrigerant during the cycle occurs

- (a) after expansion valve (b) after evaporator
(c) after condenser (d) after compression

20. In a domestic refrigerator if the compressor runs continuously, it shows that

- (a) the system is working perfectly all right
(b) the refrigerator is to full capacity
(c) the system is overloaded
(d) None of the above

21. The ratio of sensible heat to total heat is known as
- (a) Dew point
 - (b) Humidification ratio
 - (c) Specific humidity
 - (d) Sensible heat factor
22. A hermetic compressor is
- (a) a reciprocating compressor
 - (b) a valveless compressor
 - (c) a thermodynamically efficient compressor
 - (d) a factory sealed unit containing motor and compressor
23. Defrosting of evaporators is done because
- (a) Frosting increases refrigerating effect
 - (b) Frosting retards heat flow
 - (c) Frosting obstructs flow of refrigerant
 - (d) Frosting may cause damage to equipment
24. During air conditioning whenever two or more steams of moist air are mixed they follow
- (a) Adiabatic process
 - (b) Isothermal process
 - (c) Polytropic process
 - (d) Isobaric process

25. When moisture is removed from air at constant dry bulb temperature the process is known as

- (a) Drying
- (b) Humidification
- (c) Dehumidification
- (d) Sensible cooling

26. The solid solution carbon in alpha iron obtained on cooling of 0.2% carbon steel which have been heated above the third critical point is called

- (a) Ferrite
- (b) Pearlite
- (c) Austenite
- (d) Cementite

27. Which of the following is usually most ductile ?

- (a) Hexagonal close packed lattice
- (b) Body centered cubic lattice
- (c) Face centered cubic lattice
- (d) None of the above

28. If Young's modulus of elasticity is determined for mild steel in tension and in compression, the two values E_t / E_c will have a ratio of

- (a) 1
- (b) 0.5
- (c) 2
- (d) 1.2

29. The relation between the Brinell hardness number of a substance determined with P/D^2 ratio of 30 to that with P/D^2 ratio of 10 is

(a) $(PD)^2_{30} = 3 (PD)^2_{10}$ (b) $(PD)^2_{30} = (PD)^2_{10}$

(c) $(PD^2)_{30} = 9 (PD^2)_{10}$ (d) $(PD^2)_{30} = (PD^2)_{10}$

30. Close packed hexagonal space lattice is found in

(a) Chromium, tungsten and molybdenum

(b) Aluminium, copper and lead

(c) Cobalt, antimony and bismuth

(d) Calcium, magnesium and aluminium

31. The total float for any activity is defined as the difference between

(a) its latest start time and earliest start time

(b) its earliest finish time and earliest start time for its subsequent activity

(c) its latest start time and earliest start time for its subsequent activity

(d) its latest start time and earliest finish time.

32. A method of production in which machinery is used for a short time and changed when required to be used for different purpose is known as
- (a) intermittent production
 - (b) continuous production
 - (c) flow line production
 - (d) process production
33. The aim of value analysis is
- (a) to increase the cost of product after analysing different production aspects
 - (b) to reduce cost without reducing reliability and liability
 - (c) to produce goods at high costs with more utility
 - (d) to use new and costly materials
34. Which of the following is incorrect with reference to work study ?
- (a) Normal time = Representative time + Rating factor
 - (b) Normal time = Representative time $\times$ Rating factor
 - (c) Standard time = Normal time
 - (d) Standard time = Normal time $\times$ allowances

35. If the income tax goes down to total expenditures remain, we may conclude that
- (a) elasticity of demand is less than unity
 - (b) elasticity of demand is equal to unity
 - (c) elasticity of demand is greater than unity
 - (d) elasticity of demand is a function of market trends

36. Standardized normal distribution is a good approximation to
- (a) Exponential distribution
 - (b) Chi-square distribution
 - (c) Poisson distribution if λ is small
 - (d) Binomial distribution for large sample size

37. If the upper and lower control limits are within the allowable width, but are widely separated from each other, it can be concluded that
- (a) control is good but limits need to be reestablished
 - (b) the sampling plan needs revision
 - (c) a cheaper and less precise machine might be used
 - (d) control is excellent and no action is needed

38. A cloth dealer has to place an order for a new fashioned ladies sarees, but he understands that it would be outdated fairly soon. Further, he does not know the exact demand of the dress. His decision for stock will be
- (a) decision under certainty
 - (b) decision under uncertainty
 - (c) decision under risk
 - (d) decision under conflict
39. In case of break even analysis, a change in product mix is likely to influence
- (a) Profits
 - (b) Break even point
 - (c) Contribution
 - (d) All of the above
40. A dummy activity
- (a) has no sequence and can be easily fitted any where
 - (b) has only a head event but no tail event
 - (c) has no tail event but only a head event
 - (d) neither requires any resources nor any time

GROUP-C

5×6 = 30

Answer *all* questions.

Each question carries *six* marks.

1. 2.5 m^3 of gas at 800 KPa and 180°C are heated at constant pressure until the volume is doubled. $C_p = 1.0006 \text{ KJ/KgK}$ and $C_v = 0.7134 \text{ KJ/KgK}$. Calculate the change in internal energy and the work done during the process.
2. In a single stage double acting air compressor in which air is drawn in at 1 bar and compressed to 16 bar according to the law $PV^{1.25} = \text{constant}$. Indicated power of the compressor is 50 KW at 300 r.p.m and the piston speed is 180m/min. Volumetric efficiency is 80%. Calculate the diameter and stroke of the cylinder.
3. A cold storage plant is required to store 20 tonnes of fish. The fish is supplied at a temperature of 30°C . The specific heat of fish above the freezing point is 2.93 KJ / KgK . The specific heat of fish below freezing point is 1.26 KJ / KgK . The fish is stored in cold storage which is maintained at -8°C . The freezing point of fish is -4°C . The latent heat of heat of fish is 235 KJ / Kg . If the plant requires 75 KW, find
 - (a) the capacity of plant
 - (b) the time taken to achieve cooling.

4. A 4-stroke diesel engine operating with following parameters at suction condition of 0.1 MPa and 50°C. The results are as follows —

Brake power : 260 KW

Brake specific fuel consumption : 0.25 Kg / KWh

Air fuel ratio : 18:1

Volumetric efficiency : 80%

Speed : 1500 r.p.m

Determine the engine capacity (stroke volume) cylinder stroke to bore ratio is 1.25.

5. For a project following information is given.

Job i-j	Duration in days		
	Optimistic	Most Likely	Pessimistic
7-5	3	5	13
7-6	1	2	15
5-4	6	7	8
5-3	2	4	12
6-4	2	5	14
4-2	4	6	8
4-3	5	9	13
2-1	1	2	3
3-1	1	4	7

- Draw the project network
- Calculate length and variance of critical path
- With what probability the critical path will be achieved ?