Engineering Services (Main) Examination, 2026

वियोज्य *DETACHABLE*

MECHANICAL ENGINEERING

Paper I

Time Allowed : Three Hours	Maximum Marks : 300

QUESTION PAPER SPECIFIC INSTRUCTIONS

Please read each of the following instructions carefully before attempting questions.

There are **EIGHT** questions divided in **TWO** Sections.

Candidate has to attempt **FIVE** questions in all.

Questions No. **1** and **5** are **compulsory** and out of the remaining, any **THREE** are to be attempted choosing at least **ONE** question from each Section.

The number of marks carried by a question/part is indicated against it.

Wherever any assumptions are made for answering a question, they must be clearly indicated.

Diagrams/Figures, wherever required, shall be drawn in the space provided for answering the question itself.

Unless otherwise mentioned, symbols and notations carry their usual standard meanings.

Psychrometric Chart is given on Page No. 62

Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly.

Any page or portion of the page left blank in the Question-cum-Answer Booklet must be clearly struck off.

Answers must be written in **ENGLISH** only.

SECTION 'A'

1.(a) Discuss how the largest and smallest length and time scales are estimated in turbulent flows. Consider flow of water over a cylinder of diameter '$D = 0{\cdot}1$ m'. Water is at normal temperature and pressure has kinematic viscosity of $1{\cdot}01 \times 10^{-6}$ m^2/s. Also assume uniform flow at 2 km/hr. Estimate the length and frequency of smallest scale. 12

1.(b) A nozzle of a cooling tower disperses water into a stream of droplets. Find the work done to atomise 1 kg of water into droplets of the average diameter of 45 μm. Assume that water enters the nozzle through a pipe of 10 mm diameter and 1 kg of water is contained in L metres length of inlet pipe. Consider the process to be isothermal at ambient conditions, surface tension of water in contact with air = 0·1 N/m, and density of water = 980 kg/m^3. 12

1.(c) A brick wall 0·16 m thick separates combustion gases in a furnace from the atmospheric air at 30°C. The outside surface temperature of wall is at 102°C while its emissivity is 0·8 and outside heat transfer coefficient is 23 W/m^2K. Assume thermal conductivity of brick material as 1·2 W/mK. Calculate the inner surface temperature of the brick wall. Take Stefan-Boltzmann constant $(\sigma) = 5{\cdot}67 \times 10^{-8}$ W/m^2K^4. 12

1.(d) A six cylinder, four-stroke diesel engine develops 150 kW at 3500 rpm. The brake specific fuel consumption of the engine is 0·15 kg/kWh. Calculate the quantity of fuel to be injected per cycle per cylinder in cc/cycle. Consider the density of the diesel as 750 kg/m^3. 12

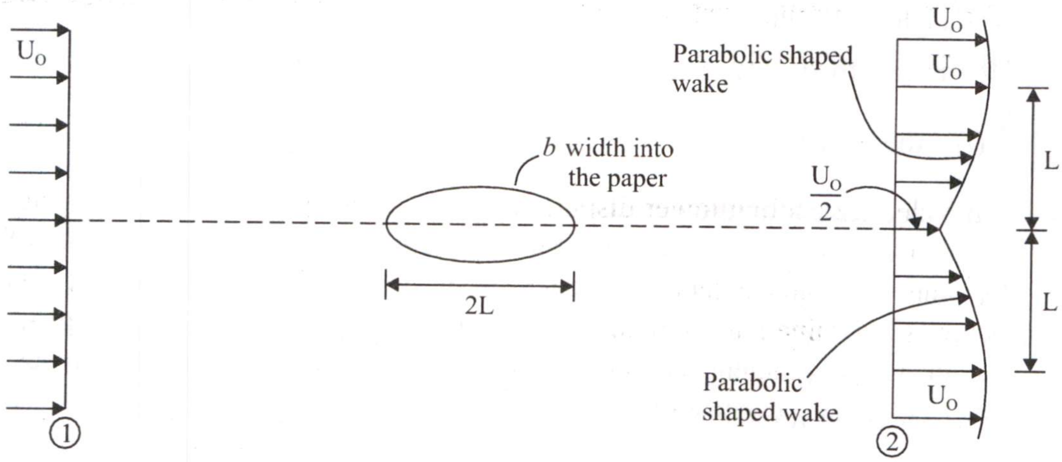
1.(e) What is meant by specific humidity ? Show that specific humidity is a function of partial pressure of water vapour. 12

2.(a)(i) A cylindrical tank of diameter D contains liquid to an initial height h_0. At time $t = 0$, a small stopper of diameter d is removed from the bottom. Using Bernoulli's equation with no losses, derive

(A) a differential equation for free surface height, $h(t)$ during draining and

(B) an expression for the time t_0 to drain the entire tank. 10

2.(a)(ii) Consider uniform flow past an elliptic cylinder with a parabolic shaped wake as shown in figure below. Pressure at sections 1 and 2 are assumed to be equal. Let b be the width of this elliptic cylinder into the paper. Find a formula for the force F on the cylinder due to the flow. Also compute coefficient of drag (C_D). 10



2.(b) Acetylene (C_2H_2) at 100 kPa and 25°C, enters an insulated mixing chamber at a rate of 0·7 kg/s. It is mixed with air at 100 kPa, 200°C, in an air/acetylene mass ratio of 15·0. The flow is steady and kinetic energy is negligible. Determine

(i) the temperature of the mixture leaving the chamber and

(ii) the irreversibility of the mixing per kg of acetylene.

Consider the mixture is discharged at an ambient pressure and temperature of 100 kPa and 25°C. Take C_P of acetylene as 1·91 kJ/kg K, C_P of air as 1·02 kJ/kg K, and C_V of acetylene and air as 1·7 kJ/kg K and 0·72 kJ/kg K, respectively. 20

2.(c) An electric current of 33995 A flows along a flat steel plate 12·4 mm thick and 101 mm wide. The temperature of one surface of the plate is 80°C and that of the other is 95°C. Find

(i) the temperature distribution across the plate

(ii) the value and position of the maximum temperature

(iii) total amount of heat generated per metre length of the plate and

(iv) the flow of heat from each surface of the plate.

The end effects along the short sides of the plate may be neglected. For steel, take resistivity as 12×10^{-6} Ω cm and thermal conductivity as 52·1 W/m K. 20

3.(a) Oil is cooled to 375 K in a parallel flow heat exchanger by transferring its heat to the cooling water that leaves the heat exchanger at 300 K. However, it is required that oil must be cooled down to 349 K by increasing the length of heat exchanger while the oil and water flow rates, their inlet temperatures and other dimensions remain unchanged. The inlet temperatures of cooling water and oil being 288 K and 426 K respectively.

If the length of heat exchanger was 1 m initially, calculate the following :

(i) the outlet temperature of the cooling water for the new heat exchanger

(ii) the length of the new heat exchanger. 20

3.(b) A two cylinder compressor has bore and stroke equal to 5·65 cm and 5 cm respectively. Its speed is 1450 r.p.m. and volumetric efficiency is 100%. If the liquid refrigerant reaches the throttle valve at 40°C, determine the (i) mass of refrigerant circulated per minute and (ii) the theoretical refrigerating capacity of the compressor when operating at a suction temperature of –10°C. Assume simple saturated cycle. How will the results get modified if clearance volumetric efficiency is also considered with a clearance factor of 3·9%. Assume $\gamma = 1{\cdot}14$ for the refrigerant. The properties of the refrigerant are given below :

Temperature (°C)	Pressure (bar)	Specific volume of vapour υ_g(m^3/kg)	Enthalpy liquid (kJ/kg) h_f	Enthalpy vapour (kJ/kg) h_g	Entropy liquid (kJ/kg K) s_f	Entropy vapour (kJ/kg K) s_g
–10	2·1928	0·07702	190·72	347·96	0·9656	1·5632
40	9·5944	0·01863	239·29	368·67	1·1324	1·5456

Also calculate loss of refrigerating capacity due to flashing in the expansion device in both cases. 20

3.(c) A perfectly insulated rigid tank having a volume of 0·3 m^3 contains water at 150°C in the saturation state, with 25% of the volume occupied by liquid. A valve on the top of the tank is opened, and vapour is allowed to escape until the pressure drops to 1 atm and the temperature to 100°C, at which the valve is closed. Calculate the mass of the vapour which leaves the tank. Assume that the steam leaves at an average enthalpy corresponding to the temperatures mentioned.

Take the properties from the steam tables given at the end. 20

4.(a) 806 kg/h of cream cheese at 16°C is pumped through a tube 100 mm in diameter, 1·74 m long and maintained at 94°C. Calculate :

(i) the temperature of cheese leaving the heated section and

(ii) the rate of heat transfer from tube to the cheese.

Use the following correlation for laminar flow inside a tube :

$$\overline{Nu} = \frac{\bar{h}D}{k} = 3{\cdot}65 + \frac{0{\cdot}067\left[\left(\frac{D}{L}\right)Re.\,Pr\right]}{1 + 0{\cdot}04\left[\left(\frac{D}{L}\right)Re.\,Pr\right]^{\frac{1}{3}}}$$

The thermophysical properties of cheese are :

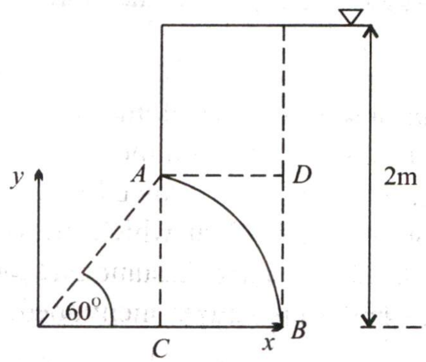
ρ = 1150 kg/m^3

μ = 22·5 kg/ms

k = 0·42 W/m °C

C_p = 2·75 kJ/kg °C 20

4.(b)(i) Determine the magnitude and direction of total pressure exerted by water on the curved surface *AB* which is quadrant of a circular cylinder as shown in the figure. The cylinder is 3 m long and has a diameter of 1 m. 10



4.(b)(ii) The velocity field for a flow in a rectangular cartesian system are given by

$$U = x(1+t)$$
$$V = 1$$
$$W = 0$$

For this flow field find the equation of :

(A) Streamline passing the point (1, 1) at $t = 0$

(B) Pathline of a particle released at the point (1, 1) at $t = 0$

(C) Steakline at $t = 0$ that passes through (1, 1)

(D) The density on a particular streamline in this flow has the value ρ_0 which is constant at time $t = 0$. Derive an expression for density ρ at any subsequent time t on the same streamline. 10

4.(c)(i) Illustrate the various stages of combustion in CI engines using the neat sketch of pressure-θ diagram. 10

4.(c)(ii) In a fuel injection pump of a diesel engine, the volume of the fuel in the pump barrel before the commencement of the effective stroke is 8·0 cc. The fuel pipe line is 3·5 mm in diameter and 500 mm in length. The fuel in the injection valve is 3·0 cc. Assume the coefficient of compressibility of diesel to be 80×10^{-6} per bar. Take the atmospheric pressure as 1 bar. Determine,

(A) the displacement of the plunger to deliver 0·2 cc of fuel at 200 bar

(B) the effective stroke of the plunger having a diameter of 8 mm. 10

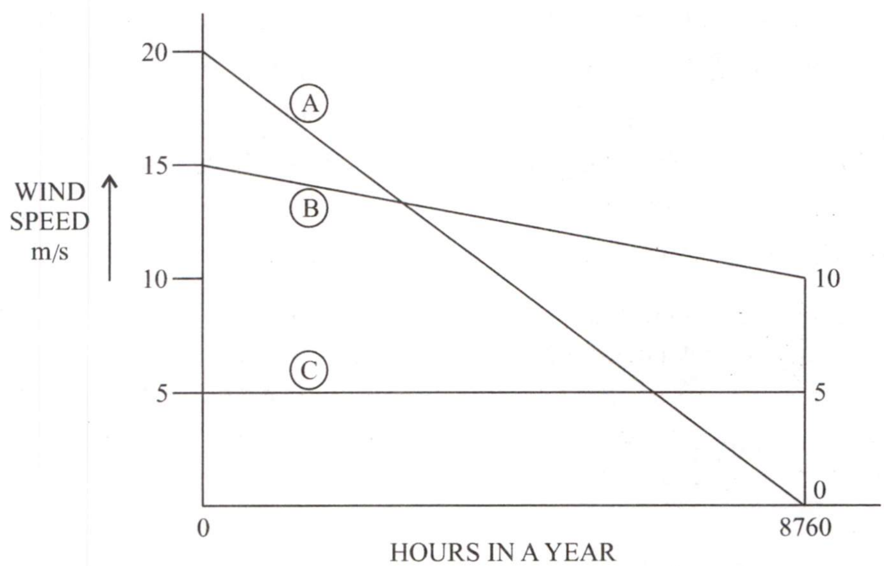
SECTION 'B'

5.(a) Consider an experimental test rig for measuring performance of a reciprocating pump. It was found that the pressure gauges which are fixed at outlet and inlet side of the pump, shows too much fluctuations in these readings. Identify the error and suggest the way for its removal. Also, derive the work saved by adding the device for its removal. 12

5.(b) A coal based thermal power plant generating 500 MW of power is having overall efficiency of 40%. It uses coal having ultimate analysis of C – 70%, H – 3%, S – 1%, O – 5% and remaining ash. Determine the amount of coal consumed in tonnes per hour. Also find out the air required to be supplied by FD fan for combustion inside the boiler in kg/s.

Take heat released by completely combusting 1 kg of C, H and S as 33800 kJ/kg, 144500 kJ/kg and 9380 kJ/kg respectively. Assume air contains 23% of oxygen by mass and 20% excess air is required to ensure complete combustion of the coal. 12

5.(c)



Wind speed-duration curve at three locations are given in the above figure as A, B, and C. Select the most suitable location to install a wind mill for power generation. Also find out the sweep area of the wind mill required to have installed capacity of 1 MW in that location taking average wind velocity. Assume the density of air as $1 \cdot 2\ kg/m^3$ and efficiency of wind mill as 40%.

Also find the length of each blade required. 12

5.(d) An inward flow reaction turbine, having an external diameter of 4 m runs at 200 rpm. The velocity of flow at inlet is 10 m/s. If the guide blade angle is 13°, find

(i) the absolute velocity of water

(ii) the velocity of whirl, at inlet

(iii) the inlet vane angle, and

(iv) the relative velocity at inlet. 12

5.(e) Derive the theoretical power coefficient of a horizontal axis wind turbine. 12

6.(a) An office building is to be air-conditioned for 50 staff for outdoor conditions of 30°C DBT and 75% R.H. If the quantity of outdoor air supplied is $0{\cdot}4\ m^3/min/person$, find the following :

(i) Capacity of cooling coil in Tons of refrigeration.

(ii) Capacity of heating coil in kW.

(iii) Amount of water removed per hour.

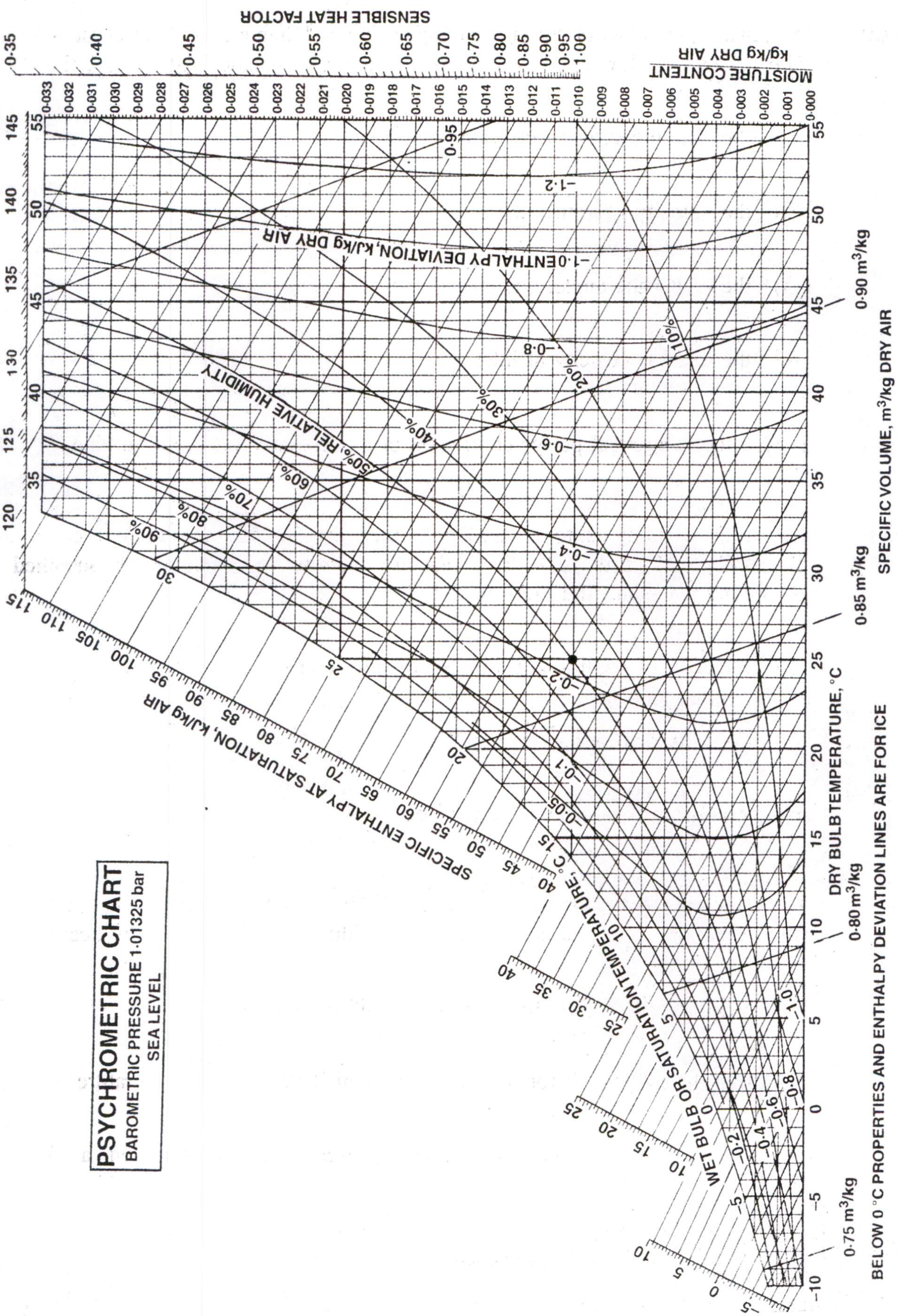
The required comfort conditions are 21°C DBT and 60% R.H. Air is conditioned first by passing it over a cooling and dehumidifying coil and then by heating.

The by-pass factor for cooling and dehumidifying coil = 0.

Also find the by-pass factor of the heating coil if its surface temperature is 25°C.

Show the scheme of processes and represent the processes on a skeleton psychrometric chart.

The psychrometric chart is attached. 20


PSYCHROMETRIC CHART
BAROMETRIC PRESSURE 1·01325 bar
SEA LEVEL
SENSIBLE HEAT FACTOR
MOISTURE CONTENT kg/kg DRY AIR
ENTHALPY DEVIATION, kJ/kg DRY AIR
RELATIVE HUMIDITY
SPECIFIC ENTHALPY AT SATURATION, kJ/kg AIR
WET BULB OR SATURATION TEMPERATURE, °C
DRY BULB TEMPERATURE, °C
SPECIFIC VOLUME, m³/kg DRY AIR
BELOW 0 °C PROPERTIES AND ENTHALPY DEVIATION LINES ARE FOR ICE

6.(b)(i) Explain the factors affecting the generation of biogas using the biodigestion method. 10

6.(b)(ii) The observed difference between the high and low water tide is 7·0 m, for a proposed tidal site. The basin area is $4{\cdot}0 \times 10^5$ m^2, which can generate power for 2 hours in each cycle. The average available head is assumed to be 6·5 m and the overall efficiency of the generation is 65%. Calculate the power at any instant and yearly power output. Take the density of the sea water to be 1025 kg/m^3 and the total number of tidal cycle in a year is 705. 10

6.(c) Compare and justify the sub-critical and super critical power boiler operations based on the following parameters :

(i) Tube thickness

(ii) Need for boiler drum

(iii) Operating pressure

(iv) Specific coal consumption

(v) Initial and operating cost 20

7.(a) If V_{f1} and V_{f2} are velocities of flow at inlet and outlet, υ_2 the tangential velocity of impeller at outlet and ϕ vane angle at outlet, show the following :

(i) Pressure rise in impeller of a centrifugal pump when frictional and other losses in the impeller are neglected, is given by

$$\Delta P = \frac{1}{2g}\left(V_{f1}^2 + \upsilon_2^2 - V_{f2}^2 \operatorname{cosec}^2\phi\right)$$

(ii) Ideal efficiency of a pump,

$$\eta_i = \frac{1}{2\gamma(\gamma - \psi \cot\phi)}$$

here, γ is the speed ratio and ψ is the flow ratio. 20

7.(b) Condenser of a thermal power plant located in northern part of India needs to operate *at various climates*. A typical condenser during winter takes water at 5°C and is connected to cooling tower having range of 12°C. The same condenser during summer takes in water at 30°C and connected to cooling tower having range of 6°C due to high humidity of air. Minimum terminal temperature difference (TTD) must be 6°C to ensure proper condensation. For this condenser find out the following :

(i) Minimum exit pressure permissible at turbine outlet during summer and winter.

(ii) Expected performance efficiency, comparison of the power plant during summer and winter.

(iii) Compare the cooling load on the condenser during summer and winter.

(iv) LMTD of the condenser during summer and winter.

(v) Justify the reason for more power cuts during summer based on this question.

[Steam table is given at the end of the question paper] 20

7.(c) A solar flat plate collector of 1 m × 2 m size receives solar heat flux perpendicular to surface having the value of 1000 W/m^2 during peak summer. Solar absorber plate temperature is measured to be 90°C and glass temperature is measured to be 60°C. Emissivity of plate and glass surfaces are 0·9 and 0·3 respectively. Convection heat transfer coefficient in the enclosed space between the plate and glass is 8 W/m^2k. Backside of the absorber plate is covered by glass wool insulation of thickness 10 cm and convective heat transfer coefficient between back surface of the collector and atmosphere is 5 W/m^2k. The atmospheric temperature is 25°C. Neglecting heat loss from the sides, find the efficiency of the collector. Thermal conductivity of glass wool is 0·3 W/mk.

Take $\sigma = 5{\cdot}67\times10^{-8}$ W/m^2k^4. 20

8.(a) A simple turbojet is analyzed with the following data :

Given (air/compressor side) :

$T_1 = 300\ K$, $P_1 = 1$ bar;

Compressor pressure ratio, $r_P = \dfrac{P_2}{P_1} = 8$

Compressor Isentropic efficiency = $\eta_c = 0{\cdot}85$
For compressed air : $\gamma_a = 1{\cdot}4$, $C_{P,a} = 1{\cdot}005$ kJ/kg K

Combustor :

Turbine inlet temperature, $T_3 = 1200\ K$
Burner efficiency : $\eta_b = 0{\cdot}9$
Fuel LHV = 43 MJ/kg
Turbine isentropic efficiency, $\eta_{t,i} = 0{\cdot}8$
Mechanical efficiency, $\eta_M = 0{\cdot}9$
for gas $C_{P,g} = 1{\cdot}15$ kJ/kg K, $\gamma_t = 1{\cdot}33$

Nozzle and flight :

Ambient pressure $P_a = 1$ bar
Nozzle efficiency, $\eta_n = 0{\cdot}95$
Flight speed, $V_0 = 250$ m/s

Assuming nozzle is convergent only and expands to ambient if unchoked.

Calculate the following :

(i) Compute compressor specific work.

(ii) Compute fuel-air ratio.

(iii) Turbine exit stagnation temperature.

(iv) Check whether nozzle is choked ?

(v) Specific thrust and SFC. 20

8.(b) Following results are obtained after analysing the flue gas and ash of the power boiler at different time of operation.

(i) More oxygen than permissible limit.

(ii) More CO and more O_2.

(iii) More CO and nil O_2.

(iv) Presence of NO_x more than permissible limit.

(v) More unburnt carbon in fly ash and hydro ash.

Identify possible problem of combustion and suggest suitable remedial measure for each of them. 20

8.(c) Explain the use of thermal energy storage system to get continuous power generation using solar energy. Give the advantages and limitations. Also compare the latent heat and sensible heat thermal energy storage systems. 20

Saturated Water and Steam (Temperatures from 0 °C to critical point)

t	*p*	*Specific volume* m³ /kg		*Specific internal energy,* kJ/kg		*Specific enthalpy* kJ/kg			*Specific entropy* kJ/kg K		
°C	bar	v_f	v_g	u_f	u_g	h_f	h_{fg}	h_g	s_f	s_{fg}	s_g
0	0·006109	0·0010002	206·3	−0·03	2375·3	−0·02	2501·4	2501·3	−0·0001	9·1566	9·1565
0·01*	0·006112	0·0010002	206·2	0·00	2375·3	0·01	2501·3	2501·4	0·000	9·156	9·156
1	0·006567	0·0010002	192·6	4·2	2376·7	4·2	2499·0	2503·2	0·015	9·115	9·130
2	0·007056	0·0010001	179·9	8·4	2378·1	8·4	2496·7	2505·0	0·031	9·073	9·104
3	0·007577	0·0010001	168·1	12·6	2379·5	12·6	2494·3	2506·9	0·046	9·032	9·077
4	0·008131	0·0010001	157·2	16·8	2380·9	16·8	2491·9	2508·7	0·061	8·990	9·051
5	0·008721	0·0010001	147·1	21·0	2382·3	21·0	2489·6	2510·6	0·076	8·950	9·026
6	0·009349	0·0010001	137·7	25·2	2383·6	25·2	2487·2	2512·4	0·091	8·909	9·000
7	0·01002	0·0010002	129·0	29·4	2385·0	29·4	2484·8	2514·2	0·106	8·869	8·975
8	0·01072	0·0010002	120·9	33·6	2386·4	33·6	2482·5	2516·1	0·121	8·829	8·950
9	0·01148	0·0010003	113·4	37·8	2387·8	37·8	2480·1	2517·9	0·136	8·789	8·925
10	0·01228	0·0010004	106·4	42·0	2389·2	42·0	2477·7	2519·7	0·151	8·750	8·901
11	0·01312	0·0010004	99·86	46·2	2390·5	46·2	2475·4	2521·6	0·166	8·711	8·877
12	0·01402	0·0010005	93·78	50·4	2391·9	50·4	2473·0	2523·4	0·181	8·672	8·852
13	0·01497	0·0010007	88·12	54·6	2393·3	54·6	2470·7	2525·3	0·195	8·632	8·828
14	0·01598	0·0010008	82·85	58·8	2394·7	58·8	2468·3	2527·1	0·210	8·595	8·805
15	0·01705	0·0010009	77·93	63·0	2396·1	63·0	2465·9	2528·9	0·224	8·557	8·781
16	0·01818	0·001001	73·33	67·2	2397·4	67·2	2463·6	2530·8	0·239	8·519	8·758
17	0·01938	0·001001	69·04	71·4	2398·8	71·4	2461·2	2532·6	0·253	8·482	8·735
18	0·02064	0·001001	65·04	75·6	2400·2	75·6	2458·8	2534·4	0·268	8·444	8·712
19	0·02198	0·001002	61·29	79·8	2401·6	79·8	2456·5	2536·3	0·282	8·407	8·690
20	0·02339	0·001002	57·79	84·0	2402·9	84·0	2454·1	2538·1	0·297	8·371	8·667
21	0·02487	0·001002	54·51	88·1	2404·3	88·1	2451·8	2539·9	0·311	8·334	8·645
22	0·02645	0·001002	61·45	92·3	2405·7	92·3	2449·4	2541·7	0·325	8·298	8·623
23	0·02810	0·001002	48·57	96·5	2407·0	96·5	2447·0	2543·5	0·339	8·262	8·579
24	0·02985	0·001003	45·88	100·7	2408·4	100·7	2444·7	2545·4	0·353	8·226	8·579
25	0·03169	0·001003	43·36	104·9	2409·8	104·9	2442·3	2547·2	0·367	8·191	8·558
26	0·03363	0·001003	40·99	109·1	2411·1	109·1	2439·9	2549·0	0·382	8·155	8·537
27	0·03567	0·001004	38·77	113·2	2412·5	113·2	2437·6	2550·8	0·396	8·120	8·516
28	0·03782	0·001004	36·69	117·4	2413·9	117·4	2435·2	2552·6	0·409	8·086	8·495
29	0·04008	0·001004	34·73	121·6	2415·2	121·6	2432·8	2554·5	0·423	8·051	8·474
30	0·04246	0·001004	32·89	125·8	2416·6	125·8	2430·5	2556·3	0·437	8·016	8·453
31	0·04496	0·001005	31·17	130·0	2418·0	130·0	2428·1	2558·1	0·451	7·982	8·433
32	0·04759	0·001005	29·54	134·2	2419·3	134·2	2425·7	2559·9	0·464	7·948	8·413
33	0·05034	0·001005	28·01	138·3	2420·7	138·3	2423·4	2561·7	0·478	7·915	8·393
34	0·05324	0·001006	26·57	142·5	2422·0	142·5	2421·0	2563·5	0·492	7·881	8·373
35	0·05628	0·001006	25·22	146·7	2423·4	146·7	2418·6	2565·3	0·505	7·848	8·353

*u_f and s_f are chosen to be zero for saturated liquid at the triple point.

t	p	Specific volume m^3/kg		Specific internal energy, kJ/kg		Specific enthalpy kJ/kg			Specific entropy kJ/kg K		
°C	bar	v_f	v_g	u_f	u_g	h_f	h_{fg}	h_g	s_f	s_{fg}	s_g
36	0·05947	0·001006	23·94	150·9	2424·7	150·9	2416·1	2567·1	0·519	7·815	8·334
37	0·06281	0·001007	22·74	155·0	2426·1	155·0	2413·9	2568·9	0·532	7·782	8·314
38	0·06632	0·001007	21·60	159·2	2427·4	159·2	2411·5	2570·7	0·546	7·749	8·295
39	0·06999	0·001007	20·53	163·4	2428·8	163·4	2409·1	2572·5	0·559	7·717	8·276
40	0·07384	0·001008	19·52	167·6	2430·1	167·6	2406·7	2574·3	0·573	7·685	8·257
41	0·07786	0·001008	18·57	171·7	2431·5	171·7	2404·3	2576·0	0·586	7·652	8·238
42	0·08208	0·001009	17·67	175·9	2432·8	175·9	2401·9	2577·8	0·599	7·621	8·220
43	0·08649	0·001009	16·82	180·1	2434·2	180·1	2399·5	2579·6	0·612	7·589	8·201
44	0·09111	0·001010	16·02	184·3	2435·5	184·3	2397·2	2581·5	0·626	7·557	8·183
45	0·09593	0·001010	15·26	188·4	2436·8	188·4	2394·8	2583·2	0·639	7·526	8·165
46	0·1010	0·001010	14·54	192·6	2438·2	192·6	2392·4	2585·0	0·652	7·495	8·147
47	0·1062	0·001011	13·86	196·8	2439·5	196·8	2390·0	2586·8	0·665	7·464	8·129
48	0·1118	0·001011	13·22	201·0	2440·8	201·0	2387·6	2588·6	0·678	7·433	8·111
49	0·1175	0·001012	12·61	205·1	2442·2	205·1	2385·2	2590·3	0·691	7·403	8·094
50	0·1235	0·001012	12·03	209·3	2443·5	209·3	2382·7	2592·1	0·704	7·372	8·076
52	0·1363	0·001013	10·97	217·7	2446·1	217·7	2377·9	2595·6	0·730	7·312	8·042
54	0·1502	0·001014	10·01	226·0	2448·8	226·0	2373·1	2599·1	0·755	7·253	8·008
55	0·1576	0·001015	9·568	230·2	2450·1	230·2	2370·7	2600·9	0·768	7·223	7·991
56	0·1653	0·001015	9·149	234·4	2451·4	234·4	2368·2	2602·6	0·781	7·194	7·975
58	0·1817	0·001016	8·372	242·8	2454·0	242·8	2363·4	2606·2	0·806	7·136	7·942
60	0·1994	0·001017	7·671	251·1	2456·6	251·1	2358·5	2609·6	0·831	7·078	7·909
62	0·2186	0·001018	7·037	259·5	2459·3	259·5	2353·6	2613·1	0·856	7·022	7·878
64	0·2393	0·001019	6·463	267·9	2461·8	267·9	2348·7	2616·5	0·881	6·965	7·846
65	0·2503	0·001020	6·197	272·0	2463·1	272·1	2346·2	2618·3	0·894	6·937	7·831
66	0·2617	0·001021	5·943	276·2	2464·4	276·2	2343·7	2619·9	0·906	6·910	7·816
68	0·2859	0·001022	5·471	284·6	2467·0	284·6	2338·8	2623·4	0·930	6·855	7·785
70	0·3119	0·001023	5·042	293·0	2469·6	293·0	2333·8	2626·8	0·955	6·800	7·755
75	0·3858	0·001026	4·131	313·9	2475·9	313·9	2321·4	2635·3	1·015	6·667	7·682
80	0·4739	0·001029	3·407	334·9	2482·2	334·9	2308·8	2643·7	1·075	6·537	7·612
85	0·5783	0·001033	2·828	355·9	2488·4	355·9	2296·0	2651·9	1·134	6·410	7·544
90	0·7014	0·001036	2·361	376·9	2494·5	376·9	2283·2	2660·1	1·192	6·287	7·479
95	0·8455	0·001040	1·982	397·9	2500·6	397·9	2270·2	2668·1	1·250	6·166	7·416
100	1·01325	0·001044	1·673	418·9	2506·5	419·0	2257·0	2676·0	1·307	6·048	7·355
150	4·758	0·001091	0·3928	631·7	2559·5	632·2	2114·3	2746·5	1·842	4·996	6·838
200	15·54	0·001157	0·1274	850·7	2595·3	852·5	1940·7	2793·2	2·331	4·101	6·432
250	39·73	0·001251	0·0501	1080·4	2602·4	1085·4	1716·2	2801·6	2·793	3·280	6·073
300	85·81	0·001404	0·0217	1332·0	2563·0	1344·0	1404·9	2749·0	3·253	2·451	5·704
350	165·13	0·001740	0·0088	1641·9	2418·4	1670·6	893·4	2563·9	3·778	1·433	5·211
374.15*	221·2	0·003155	0·003155	2029·6	2029·6	2099·3	0·0	2099·3	4·4298	0·0	4·4298

*Critical point. Note : h_{fg} and s_{fg} values are zero at critical point.