(3 Hours)   **[Total marks: 80]**

N.B.: (1) Question No 1 is compulsory
       (2) Attempt any three questions out of remaining five questions
       (3) Assume suitable data if necessary and indicate it clearly.
       (4) Figures to the right indicate full marks.

Q.1.   Solve the following (Any Four)

    (a)   Differentiate between commercial and non-commercial energy sources   **05**

    (b)   Which different documents need to be reviewed during energy audit and   **05**
        why?

    (c)   How variable speed drives (VSDs) helps in energy saving and why VSDs   **05**
        are to be installed on cooling tower fans?

    (d)   Explain the concept of threshold approach temperature difference in heat   **05**
        exchanger networking.

    (e)   How quality of waste heat is decided and further how waste heat recovery is   **05**
        classified?

    (f)   What are the advantages of solar energy?   **05**

Q.2. (a)   What is the meaning of energy performance of any industrial plant and how   **10**
        it is evaluated? If, for a particular plant, reference year energy use is 12000
        kCal, current year's energy use is 10000 kCal and production factor for
        current year is 0.9, then what is the plant energy performance for this plant?

    (b)   Discuss in detail any five energy efficient steps to be followed to improve   **10**
        energy efficiency of compressed air system

Q.3. (a)   For following process stream data, evaluate $Q_{H,min}$, $Q_{C,min}$ and Pinch   **10**
        temperature for $\Delta Tmin = 20\ ^oC$

Process Stream	1	2	3	4
$T^s\ (^oC)$	140	100	60	30
$T^t\ (^oC)$	70	40	80	120
$C\ (kW\,/\,^oC)$	4	6	5	3

    (b)   Explain direct and indirect benefits of waste heat recovery.   **10**

Q.4. (a)   Design a feasible HEN (without violation of ΔTmin criteria) for   **10** following process stream data at **ΔTmin = 20 ^{o}C; From pinch analysis,**

           $Q_{H,min}$ =155 kW, $Q_{C,min}$ = 110 kW, Hot Pinch T = 90°C

Process Stream	1	2	3	4
T^{s} (^{o}C)	150	90	25	20
T^{t} (^{o}C)	60	60	100	125
C (kW / ^{o}C)	5	16	6	5

    (b)   Calculate minimum number of heat exchangers (NHx,min) required for the   **10** process stream data described in Q.4 (a) and redesign the heat exchanger network for the same to achieve NHx,min target using breaking loop method.

Q.5. (a)   Why waste heat should be recovered? With the help of suitable diagram,   **10** describe about "Heat Wheel" used to recover waste heat.

    (b)   Explain working, advantages and disadvantages of steam turbine   **10** cogeneration system with the help of suitable diagram.

Q.6. (a)   Explain the working, advantages, disadvantages and applications of wind   **12** energy.

    (b)   Define the following terms briefly: **08**
        (i)   Energy conservation opportunity
        (ii)   Blowdown of boiler
        (iii)   Renewable energy
        (iv)   Cogeneration

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