TE (Mech), Sem-V, A.T.K.T, Hydraulic Machinery

Lib 26/06/15

DEPARTMENT OF MECHANICAL ENGINEERING, SPCE

TE (Mechanical), SEM-V, KT- Examination, JUNE 2015

[Hydraulic Machinery]

- **Question no 1 is compulsory**
- Attempt **any four out of remaining six** questions.
- Figures to the right (in bold) indicate full marks.
- Make suitable assumptions if necessary

Time : 3 Hour
Marks: 100

Masters.

1	a	State five advantages of hydro power plant over other types of power plant	5
	b	Explain the term NPSH. What is the difference between NPSH available and NPSH required?	5
	c	What is 'slip' in reciprocating pumps? State the conditions under which negative slip can occur	5
	d	Differentiate between impulse and reaction Turbines	5
2	a	The impeller of a centrifugal pump has an external diameter of 500mm and an internal diameter of 250mm. The impeller width at outlet is 60mm and it rotates at 1200 rpm against a head of 40m. The velocity of flow through the impeller is constant and equal to 3m/s. The vanes are setback at an angle of 35^0 at outlet. Determine: (a) Inlet vane angle (b) Work done by the impeller on water per second (c) Manometric efficiency	12
	b	With a neat sketch, explain the construction and working of a pelton wheel turbine	8
3	a	Show that percentage of work saved in pipe friction by fitting of air vessels for a single acting pump is 84.8% and that for a double acting reciprocating pump is 39.2%	10
	b	Explain methods to balance axial thrust and radial thrust in a centrifugal pump	6
	c	Explain specific speed of a turbine? What is its importance	4
4	a	Table below gives the head- discharge efficiency characteristics of a centrifugal pump. Two pumps of the above type are connected in series to a system. The system characteristics are given in row 4 of the table. (a) Calculate the operating point when i. Only one pump is working ii. When two pumps connected in series are working (b) Calculate the brake power required in both the cases mentioned above	12

Head H(m)	22	20	21	19	17	15	12	9	6	3
Discharge of one pump (l/s)	0	20	40	60	70	80	92	100	110	120
Efficiency (%)	0	35	60	80	84	87	85	78	65	45
System(H-Q) characteristics, H=(m)	10	10	11	12.9	14	15.1	16.3	18	19.7	21.5

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b What is a draft tube? Explain its functioning. Sketch and explain its any two types. 8

5 a A Francis turbine is to be designed to develop 3700kW of power under a head of 70mwhile running at a speed of 600rpm. Following are some data of the turbine: ratio of width of runner to outer diameter of the runner = 0.1, ratio of inner diameter to outer diameter of the runner = 0.5, flow ratio = 0.25, hydraulic efficiency = 95%, mechanical efficiency = 80%, circumferential area occupied by thickness of vanes = 10%, Assuming constant flow velocity and radial discharge at outlet, calculate (a) guide vane angle, (b) runner blade angle at inlet, (c) blade angle at the outlet 12

b Explain the performance characteristic curves of a centrifugal pump 8

6 a A single jet Pelton wheel turbine is required to drive a generator to develop 10000kW. The available head at the nozzle is 760m. Assume the following: Electric generator efficiency 95%, pelton wheel efficiency 87%, coefficient of velocity for nozzle as 0.97, mean bucket velocity 0.46 of jet velocity, outlet angle of buckets 15^0 and relative velocity of the water leaving the buckets 0.85 of that at inlet, Find- 10

(a) Diameter of jet
(b) Flow in m^3/s
(c) Force exerted by jet on the buckets

6 b Explain the term cavitation and state its causes. Explain how cavitation can be prevented in hydraulic turbines 10

7 a Obtain an expression for work done per second by water on the runner of a pelton wheel 10

b Explain the governing of a reaction turbine with neat sketches. 6

c Explain the need for a surge tank in a high head power plant 4

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Thermal systems

BHARTIYA VIDYA BHAVAN'S

SARDAR PATEL COLLEGE OF ENGINEERING

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MUNSHI NAGAR, ANDHERI(WEST), MUMBAI-400 058

KT-EXAM- JUNE 2015

CLASS/SEM: **T.E. (Mechanical)/V** TOTAL MARKS:**100**

SUBJECT: **Thermal Systems (ME-304)** DURATION: **3 HOUR**

1. Answer any **Five** questions out of **Seven** questions.
2. Figures to the right indicate full marks.
3. Assume suitable data and justify the same.
4. Use of steam table and Mollier chart is permitted.

Master

Q.1 Answer the followings [20]

(a) Enumerate various applications of compressed air.

(b) Differentiate between high pressure and low pressure boilers.

(c) Explain multistaging in reciprocating air compressors.

(d) Differentiate between impulse and reaction turbine.

Q.2(a) Prove that the condition for minimum work per kg of air delivered by two stage compressor when intercooling is perfect is given by

$$P_2 = \sqrt{P_1 P_3}$$ **[08]**

(b) A two stage single acting air compressor delivers air at 20 bar. The pressure and temperature of the air before the compression in L.P. cylinder are 1 bar and 27° C. The discharge pressure of L.P. cylinder is 4.7 bar. The pressure of air leaving the inter-cooler is 4.5 bar and the air is cooled to 27° C. The diameter and stroke of L.P. cylinder are 40 cm and 50 cm respectively. The clearance volume is 4% of stroke in both cylinders. The speed of the compressor is 200 r.p.m. Assuming the index of compression and re-expansion in both cylinders is 1.3 find indicated power required to run the compressor and heat rejected in the intercooler per minute.
Take C_p = 1 kJ/kg-K and R = 287 J/kg-K for air. **[12]**

Q.3 (a) Compare rotary and reciprocating compressor **[08]**

(b) Explain complete Rankine cycle and compare it with Carnot cycle. **[12]**

Q.4(a) Discuss the requirements of a good boiler. **[10]**

(b) Distinguish between water-tube and fire-tube boilers and state under what circumstances each type would be desirable. **[10]**

Q.5(a) Explain evaporative condenser with neat sketch. **[10]**

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Thermal Systems

(b)The inlet condition of steam of steam to a convergent-divergent nozzle is 2.2 MN/m^2. Assuming frictionless flow up to the throat and a nozzle efficiency of 85 percent. (i) determine the flow rate for a throat area of 32.2 cm^2 (ii) the exit area. **[10]**

Q.6 (a)What are the different methods of compounding of steam turbine stages. List the advantages and limitations of velocity compounding **[08]**

(b)The following data refer to one stage of an impulse turbine:
Isentropic nozzle heat drop = 185 kJ/kg
Reheat of steam due to blade friction = 10% of isentropic drop
Nozzle angle = 20°.
Ratio of blade speed to whirl component of steam speed = 0.5
Velocity coefficient for the blades = 0.95
Take this velocity of steam at the entry of nozzle = 30 m/sec.
Find (i) blade angle if the steam leaves axially, (b) work done per kg and (c) friction loss over the blades and K.E. loss. **[12]**

Q.7 (a) Discuss the means of improving the specific output and thermal efficiency of the simple open cycle gas turbine plant. **[08]**

(b)The air supplied to a gas turbine plant is 10 kg/s. The pressure ratio is 6 and pressure at the inlet of compressor is 1 bar. The compressor is two-stage and is provided with perfect intercooling. The inlet temperature is 300 K. Take the following data and calculate the thermal efficiency of the plant.
Isentropic efficiency of compressor at each stage = 80 %.
A regenerator is included in a plant whose effectiveness is 0.7.
Neglect the mass of fuel.
Take C_p for air as 1.005 kJ/kg K. **[12]**

TE (Mech), Sem-V, A·T·K·T,
Heat & Mass Transfer

NB
23/06/15

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KT EXAMINATION, May 2015

SEM / CLASS: SEM V / T. E. (MECH. ENGG) **TOTAL MARKS: 100**
SUB: Heat and Mass Transfer **TIME: 03 HR**

- Use of Steam Table and Heat Transfer Data Book are allowed.
- Attempt **any Five questions** out of Seven questions.
- Answers to all sub questions should be grouped together.
- Figures to the right indicate full marks.
- Make suitable assumptions with proper explanations.
- Draw the suitable sketches wherever necessary

Master

Q.1. (A) A steam pipe of outer diameter 120 mm is covered with two layers of lagging, inside layer 45 mm thick (k 0.08 W/mK) and outside layer 30 mm thick (k 0.08 W/mK). The pipe conveys steam at a pressure of 20 bar with 50°C superheat. The outside temperature of lagging is25°C. If the steam pipe is 30 meter long, determine:

1. Heat loss per hour, and
2. Interface temperature of lagging

The thermal resistance of steam pipe may be neglected. **(10)**

(B) A longitudinal copper fin (k = 380 W/mK) 600 mm long and 5 mm diameter is exposed to air steam at 20°C. The convective heat transfer coefficient is 20 W/m^2K. If the fin base temperature is 150°C, determine:

(1) The heat transferred, and
(2) The efficiency of the fin. **(10)**

Q.2. (A) An egg with mean diameter of 45 mm initially at 15°C is placed in a boiling water pan for 6 min and found to be boiled to the consumer's taste. For how long should a similar egg for same consumer be boiled when taken from a refrigerator at 4°C. Take the following properties for egg:

K 10 W/mk, ρ = 1200 kg/m^3, Cp 2 kJ / kg.K, h = 100 W/m^2K.

(Use lumped system analysis) **(10)**

(B) What is dimensional analysis? What are the advantages and limitations of the dimensional analysis? What are the dimensionless numbers? Give the physical significance of at least two dimensionless numbers. **(10)**

Q.3. (A) Explain thermal boundary layer and velocity boundary layer with neat sketches. What is the importance of these boundary layers in heat transfer? **(10)**

(B) Water is heated while flowing through a 1.5 cm x 3.5 cm rectangular tube at a velocity of 1.2 m/s. The entering water temperature is 40°C and tube wall is maintained at 85°C. Determine the length of the tube required to raise the temperature of water by 53°C.

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Heat & Mass transfer

K = 0.653 W/mk, ρ = 985.5 kg/m^3, $\nu = 0.517 \times 10^{-6} \frac{m^2}{s}$ Cp = 4.19 kJ / kg.K
Use the co-relation as: $Nu = 0.023\ (Re)^{0.8}\ (Pr)^{0.33}$ **(10)**

Q.4. (A) Explain the difference between convective heat transfer coefficient and overall heat transfer coefficient. Explain significance of Prandtl number and Reynolds number. What is turbulent flow? **(10)**

(B) Estimate the heat transfer from a 60 W incandescent bulb at 115°C to 25°Cin quiescent air. Approximate the bulb as a 50 mm diameter sphere. What percent of the power is lost by free convection? Assume that the characteristic length is the diameter of the sphere.
Using equation:

$$Nu = 0.6\ \{(Gr.\ Pr)^{0.25}\}$$

Take properties of air at bulk mean temperature 75°C:
k = 0.03 W/mK, $\nu = 20.55 \times 10^{-6}$ m^2/s, Pr = 0.693 **(10)**

Q. 5. (A) A counter-flow heat exchanger is to heat air entering at 400°C with a flow rate of 6 kg/sec by the exhaust gas entering at 800°C with a flow rate of 4 kg/sec. The overall heat transfer coefficient is 100 W/m2 K and the outlet temperature of the air is 550°C. Specific heat at constant pressure for both air and exhaust gas can be taken as 1100 J/kg K.
Calculate:

1. The heat transfer area needed;
2. The number of transfer units. **(10)**

(B) Starting from basic show that for a heat exchanger when one fluid is condensing,
Effectiveness = $1 - e^{(-NTU)}$ **(10)**

Q.6. (A) What is meant by heat exchanger? State the utility and application of heat exchangers. Point out the different criterions that form the basis for the classification of heat exchangers. **(10)**

(B) A steel tube, 5 cm outside diameter and 2 m long, is at 500 K temperature. This tube is located centrally in (i) a large brick room having wall temperature 300 K and (ii) a square brick conduit of 20 cm side and at 300 K. If the emissivitives of steel and brick are 0.8 and 0.95 respectively, make calculations for the rate of heat loss by radiation from the tube in each case and comment on the result. **(10)**

Q.7. (A) Hydrogen gas at 25°C and 2.5 bar pressure flows through a rubber tubing of 12 mm inside radius and 24 mm outside radius. The binary diffusion coefficient of hydrogen is 2.1×10^{-8} m^2/s and the solubility of hydrogen is 0.055 m^3 of hydrogen per m3 of rubber at 1 bar. If the gas constant for hydrogen is 4160 J/kg.K and the concentration of hydrogen at the outer surface of tubing is negligible, calculate the diffusion flux rate of hydrogen per meter length of rubber tubing. **(10)**

(B) Prove that emissive power of a black body is equal to π times the intensity of radiation of black body. **(05)**

(C) What are the important modes of mass transfer? And Give at least one example of each. **(05)**