Prepp

Practice, Learn and Achieve
Your Goal with Prepp

HPPSC Recruitment

Mechanical Engineering-II

Simplifying
Government Exams

SSC CHSL | IAS EXAM | RRB NTPC | NTSE | CDS
SSC CGL | CBSE UGC NET | IBPS PO | NDA
SBI PO | IBPS CLERK | AFCAT | SSC JE | CTET
CSIR UGC NET | CAPF | IBPS RRB

www.prepp.in

[This question paper contains 03 printed pages]

Roll Number: _____

HPAS Etc. Combined Competitive (Main) Examination, 2019

Mechanical Engineering-II

Time Allowed: 3 Hours Maximum Marks: 100

Note:

1. This question paper contains total eight questions. *Attempt any five questions including compulsory question No.1.*
2. Each question carries equal marks. Marks are divided and indicated against each part of the question. Write answer in legible handwriting. Each part of the question must be answered in sequence and in the same continuation.
3. Attempts of questions shall be counted in sequential order. Unless struck off, attempt of question shall be counted even if attempted partly. Any page or portion of the page left blank in answer book must be clearly struck off.
4. *Re-evaluation / Re-checking of answer book is not allowed.*

---

1. (a) A Chiller plant working on vapor compression cycle is having a capacity of 250TR (Tonnes of Refrigeration) cools water from $9^{O}C$ to $6^{O}C$. Taking the specific heat of water as 4.2kJ/kg K, find out the maximum flow rate of water permitted in the chiller plant. If the COP of the unit is 1.5, find the number of units of electricity consumed by the plant per day assuming 24x7 operation at full load. If the electricity tariff is Rs.8/unit, find the electricity bill of running the plant per month. Also show the vapor compression cycle in P-h chart. (10)

   (b) What are the limitations of implementing the Carnot cycle for steam power plants? How these problems are addressed in the Rankine cycle? Explain with a suitable T-s plot. (10)

2. (a) Draw the typical velocity distribution for the laminar flow of fluid through a tube and deduce an expression for the velocity "U m/s" at any radius "r" at a given location in terms of center line velocity "U_o m/s**"**. Also find an expression for the average velocity at the given location. (10)

   (b) Give the reasons for the following: (10)
   i) Surface of a golf ball is deliberately made rough.
   ii) Ground clearance for the racing cars is kept very low.
   iii) Diverging section draft tubes are used in reaction turbines of a hydro power plants.
   iv) Coefficient of velocity for Orifice meter is less than a Venturi meter.
   v) Mercury is used as the manometric fluid in barometers.

3. (a) A very long cylindrical rod of stainless steel (k=20W/mK) having diameter of 2cm is used to stir hot liquid at $200^{O}C$. A human being can tolerate a temperature of only $40^{O}C$ to hold the stirrer to stir (without gloves). Find the minimum length of the rod at which the rod can be held for stirring by a human being from the surface of the liquid. Take the surrounding temperature as $20^{O}C$ and the heat transfer coefficient between the rod and the atmosphere as $20W/m^2K$. (10)

(b) Deduce an expression for the temperature distribution in an infinite slab of thickness "2L" continuously generating heat at a uniform rate of rate of "q W/m^3". One of the surfaces is maintained at a temperature of "$T_{w1}{}^{O}C$" and the other surface is maintained at a temperature of "$T_{W2}{}^{O}C$". (10)

4. (a) Deduce an expression for the shape factor of a hemi spherical cavity within itself. (10)

(b) A condenser needs to condense saturated steam entering at a rate of 400kg/s at atmospheric pressure to saturated water. Latent heat of the steam is 2350kJ/kg. Cooling water enters the condenser at a temperature of $20^{O}C$ and leaves at $30^{O}C$. Overall heat transfer coefficient is $1500W/m^2K$. Find the following:-

i) Mass flow rate of the water required.
ii) LMTD assuming correction Factor =1
iii) Total surface area required for the heat transfer.

Also suggest suitable methods to make the condenser more compact. (10)

5. (a) Explain the following methods of determining frictional power of IC Engine:- (10)

i) Morse test
ii) Retardation test
iii) Willans line method

(b) Explain the effect of following parameters on detonation in SI engines:

i) Flame front speed
ii) Ignition delay
iii) Combustion chamber temperature
iv) Distance of end charge from the spark plug
v) Addition of Tetra Ethyl Lead (TEL)

6. (a) Explain the procedure to calculate the heat loss and collector efficiency of a solar parabolic trough based concentrating collector showing the different thermal resistances involved in the heat transfer. Also give the reasons for using glass tube and evacuating the annular space between the absorber tube and glass tube. (10)

(b) Wind mill having 20m length blade is located in a region having average velocity and temperature of 10m/s and $25^{O}C$ respectively. Efficiency of the wind mill is 40%. Plant load factor is 60%. Determine the number of units of electricity generated by the wind mill/year and the revenue generated per year if the selling price per unit of electricity to the state electricity board is Rs.3/kWh. Also calculate

the payback period if the initial investment of the wind mill is Rs.4 Crores/MW of installed capacity. (10)

7. (a) A gas Turbine power plant needs to generate 210MW of net power output while operating at a maximum temperature of 1200^{O}C. Pressure ratio is 9 and the atmospheric temperature is 25^{O}C. Taking the isentropic efficiency of the compressor and turbine as 80%. Find the following:- (10)

i) Mass flow rate of the fuel required in kg/s (Calorific value of the fuel =44000kJ/kg)
ii) Efficiency of the power plant
iii) Flow rate of air required

Compare these values if two stage compression and two stage expansion is used with perfect intercooling and reheating with the optimal intermediate pressure. Take the following property values of air and gases.

Fluid	Specific Heat (kJ/kgK)	Adiabatic index
Air	1.00	1.4
Gases	1.1	1.33

(b) Draw a skeleton psychometric chart and show the suitable psychometric processes to get the human comfort under the following climatic conditions. Also explain the method of implementing these processes: (10)

i) Hot and dry climatic condition during summer in Rajasthan.
ii) Cold and dry climatic condition during winter in Himachal Pradesh.
iii) Hot and humid climatic condition during summer in coastal regions.

Why cold and humid condition does not appear in the list?

8. Explain the following:- (4 x 5=20)

i) Hydrodynamic and thermal boundary layer for the laminar flow over a flat plate
ii) Loss of coolant accidents in a Nuclear Power Plant
iii) Selection of turbine for Run off river and seasonal river
iv) Relationship between Planck's law and Stefan Boltzmann law of radiation

*****