(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 4039 Roll No.

B.Tech.

(SEM II) EVEN SEMESTER THEORY EXAMINATION, 2009-2010

MECHANICAL ENGINEERING

Time : 3 Hours *Total Marks : 100*

Note : *(i) Attempt ALL questions. Marks are indicated against each question.*

(ii) Assume missing data suitably, if any.

(iii) Use of Steam Table, Mollier's Chart is allowed.

1. Answer **any four** parts of the following : **(4x5=20)**

(a) Give the definition of "Thermal Reservoir". Explain "Thermodynamic Equilibrium".

(b) Derive an expression for the heat transfer for a polytropic process.

(c) Differentiate between refrigerator and heat pump, also derive an expression relating their COPs.

(d) Prove that the entropy is a property.

(e) A Carnot engine delivers 20 kW of power while absorbing energy as heat from a source at 1000 °C. It rejects energy as heat to a sink at 27 °C. Determine the energy absorbed and the energy rejected per second by the engine.

(f) A heat engine working between a thermal source at 400 °C and the ambient atmosphere at 25° C drives a refrigerator which operates between the ambient atmosphere and a cold space at −20 °C. Determine the ratio of the energy absorbed as heat by the engine to the energy absorbed as heat from the cold space by the refrigerator. Assume all the processes to be reversible.

2. Answer **any two** parts of the following : **(2x10=20)**

(a) Water is the working fluid in an ideal Rankine Cycle. Saturated vapor enters the turbine at 18 MPa. The condenser pressure is 6 kPa. Determine :

(i) Net work per unit mass of steam flow, in kJ/kg

(ii) Heat transfer to the steam passing through the boiler, in kJ per kg of steam flowing

(iii) Thermal efficiency

(b) At the beginning of the compression process of an air-standard Otto cycle, $P_1 = 1$ bar, $T_1 = 290$ K, $V_1 = 400$ cm^3. The maximum temperature in the cycle is 2200 K and the compression ratio is 8. Determine

(i) Heat addition

(ii) Thermal efficiency

(c) (i) Discuss the practical difficulties of Carnot vapor power cycle. How these are overcome in the Rankine cycle ? https://www.aktuonline.com

(ii) With the help of neat sketch explain the working of a two stroke CI engine.

3. Answer **any two** parts of the following : **(2x10=20)**

(a) Explain the following :

(i) Angle of friction

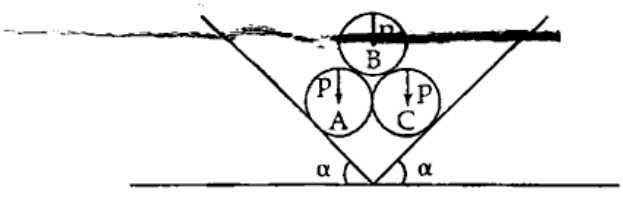
(ii) Parallelogram law of forces

(iii) Conditions of equilibrium for coplanar forces and concurrent forces.

(b) Derive the following expression for the belt, where all symbols have their usual meaning.

$$\frac{T_2}{T_1} = e^{\mu\theta}$$

(c) In figure, three smooth right circular cylinders, each of radius r and weight P, are arranged on smooth inclined surfaces as shown. Determine the least value of angle α that will prevent the arrangement from slipping.



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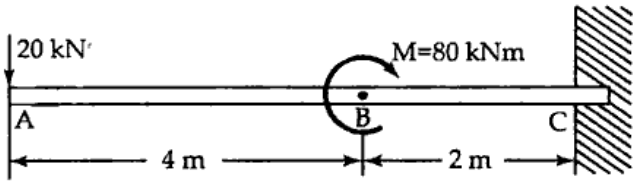
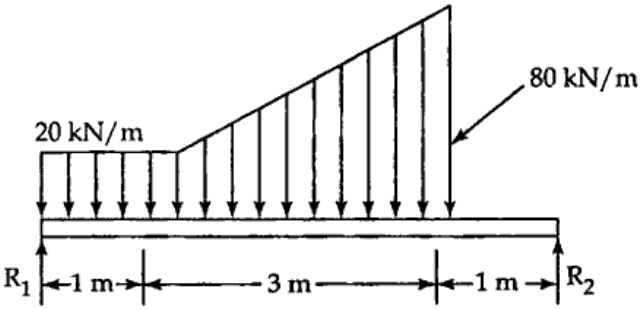
4. Answer **any two** parts of the following : **(2x10=20)**

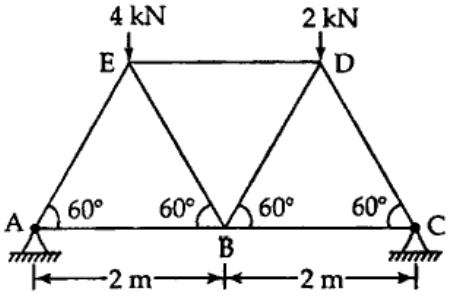
(a) Find the shear force and moment equation for the cantilever beam shown in figure. Also sketch the shear force and bending moment diagram.



(b) Give the shear force and bending moment equation for the beam. Also draw the shear force and bending moment diagrams.



(c) For the truss shown in figure, find the force in the members.



5. Answer **any two** parts of the following : **(2x10=20)**

(a) (i) For a biaxial stress system derive an expression for the normal stress acting on an oblique plane and hence derive expression for the principal stresses.

(ii) Derive the following expression for the elastic constants :

$$K=\frac{E}{3(1-2\mu)}$$

(b) A simply supported rectangular beam, 2 cm wide by 5 cm high, carries a uniformly distributed load of 5 kN/m over its entire length. What is the maximum length of the beam if the flexure stress is limited to 2.5 MPa ?

(c) (i) Derive an expression for strain energy in terms of strain and Young's modulus.

(ii) Calculate the minimum diameter of a solid steel shaft which is not allowed to twist more than 3° in a 6m length when subjected to a torque of 12kN-m. Also calculate the maximum shearing stress developed.

Take G = 83 GPa.

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