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# HPPSC Recruitment

## Mechanical Engineering-I

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[This question paper contains 04 printed pages]

Roll Number: _____

HPAS Etc. Combined Competitive (Main) Examination, 2019

Mechanical Engineering-I

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.*

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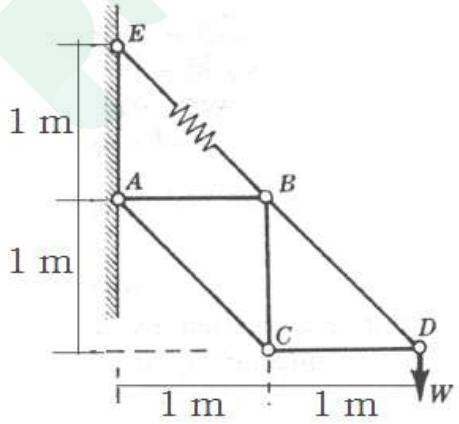
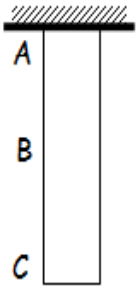
1. (a) In the figure given below, *AB*, *AC*, *BC*, *CD* and *BD* are pin connected rods. Point B is attached to point *E* by a spring whose un stretched length is 1 m and spring constant is 4 kN/m.
Neglecting the weight of all bars and spring, determine the magnitude of the load *W* applied at *D* to make *CD* horizontal. (10)




(b) A circular bar *AC* of length *L*, cross-sectional area *A*, modulus of elasticity "*E*" and mass "m" kg per unit volume hangs vertically under its own weight as shown in the figure given below.
What is the ratio of the elongation of the upper half ($\delta_{AB}$) of the bar to the elongation of the lower half ($\delta_{BC}$) of the bar. (10)



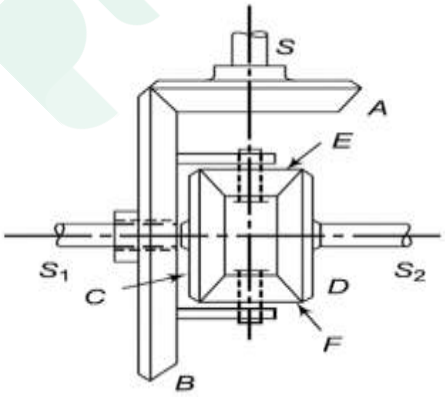

2. (a) Find the magnitude of net unbalanced secondary force in a *V* twin engine. Deduce the expression when the line of stroke of the two cylinders (2α) are at 90° to each other.

A *V* twin engine has the cylinder axes at right angles (2α = 90°) and the connecting rods operate a common crank. The reciprocating mass per cylinder is 11.5 kg and the crank radius is 75 mm. The length of connecting rod is 0.3 m. Determine the magnitude of maximum secondary force if the engine speed is 500 rpm. (10)

(b) A vehicle, with the differential shown in the figure given below, takes a turn to the left so that the right wheel becomes the outer wheel. The speed of the vehicle is 45 kmph and the radius of the turn is 30 m (at the center of the differential). The distance between the centers of the wheels is 1.65 m and the tyres are 40 cm in diameter. The number of teeth on each gear of differential shown in Figure are $N_A$ = 12, $N_B$ = 56, $N_C = N_D$ = 16 and $N_E$ = 12. Calculate:

(a) The speed of rotation (rpm) of each rear wheel (i.e. $S_1$ and $S_2$)

(b) The rotational speed (rpm) of the ring gear *B* and the drive shaft *S*. (10)




3. (a) The down sprue leading into the runner of a certain mold has a length = 175 mm. The cross-sectional area at the base of the sprue is 400 $mm^2$. The mold cavity has a volume of 0.001$m^3$. Determine: (a) the velocity of the molten metal flowing through the base of the down sprue, (b) the volumetric flow rate, and (c) the time required to fill the mold cavity. List the assumptions made in calculating these values. (10)

(b) Bar stock of initial diameter = 90 mm is drawn with a draft = 15 mm. The draw die has an entrance angle = 18°, and the coefficient of friction at the work-die interface = 0.08. The metal behaves as a perfectly plastic material with yield stress = 105

MPa. Find out the reduction in area. Also explain the difference between hot working and cold working processes. (10)

4. (a) Draw the fusion welded butt joint clearly showing the fusion zone, heat affected zone and un affected zone showing columnar grains, fine grains, coarse grain. Also explain the purpose of heat treatment on such welded joints. (10)

   (b) Suggest suitable for manufacturing processes to manufacture the following components with justification:- (10)

   i) Connecting rods of an automobile
   ii) Gears used for power transmission
   iii) Valve bodies used water pipe lines
   iv) Lathe beds
   v) Metal roof of a car
   vi) Electric cables
   vii) Railway tracks
   viii) Aluminium window frames
   ix) Metal tumbler
   x) Balls used in self lubricated ball bearings

5. (a) An automotive ancillary company is making radiator caps for the automobiles. It is interested in forecasting the sale for the next financial year 2021-22. Suggest suitable methods of sales forecasting for production planning.
   Sales manager of a coffee manufacturing company gathered the following data predicting that demand for mocha latte coffees depends on the price:-

| Price ($) | Number sold |
|---|---|
| 2.70 | 760 |
| 3.50 | 510 |
| 2.00 | 980 |
| 4.20 | 250 |
| 3.10 | 320 |
| 4.05 | 480 |

   Using these data, how many latte coffees would be forecast to be sold according to simple linear regression analysis if the price is 1.80$? (10)

   (b) Sunshine cookies manufacturing company has five production lines, each of which will be dedicated to a particular kind of cookie. The production lines differ by sophistication of machines, site, and experience of personnel. Given the following estimates of processing times (in hours), assign cookies to lines to minimize the sum of completion times: (10)

| Cookies | Production Line | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Chocolate Mint | 30 | 18 | 26 | 17 | 15 |
| Peanut Butter | 23 | 22 | 32 | 25 | 30 |
| Shortbread | 17 | 31 | 24 | 22 | 29 |
| Fudge Delight | 28 | 19 | 13 | 18 | 23 |
| Macaroons | 23 | 14 | 16 | 20 | 27 |

6. (a) In an orthogonal machining, the tool has rake angle 10°, chip thickness before cut is to = 0.51mm and chip thickness after cut is tc = 1.14mm. The cutting and thrust forces are measured as Fc =1557N and Ft = 1268N while cutting at a speed of 61m/min. Determine the chip thickness ratio, shear plane angle and machining shear strain. (10)

   (b) Identify the causes and suitable remedies for the following defects occurring during the given manufacturing process. (10)

   i) Central burst during hot rolling.
   ii) Blow holes during casting.
   iii) Spatter during welding.
   iv) Wrinkling during deep drawing.
   v) Springing back during pipe bending.

7. (a) Draw the steel region of iron and iron carbon diagram and explain the phase transformation of i) hypo eutectoid, ii) hyper eutectoid and iii) eutectoid steels. Also explain the method of arriving at carbon content in steel from the percentages phases present in the microstructure. (10)

   (b) Draw a Typical creep curve of a metallic material and explain the effect of stress and temperature on creep life material. Give some examples of industrial components needs to be designed based on creep life. (10)

8. Explain the following:- (5x4=20)
   i) Engineering stress and true stress
   ii) Just in Time (JIT) Technology for inventory control
   iii) Product and process layout
   iv) Eutectic system of phase diagram

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