This question paper contains 8+2 printed pages]

HPAS (M)—2014

MECHANICAL ENGINEERING

Paper I

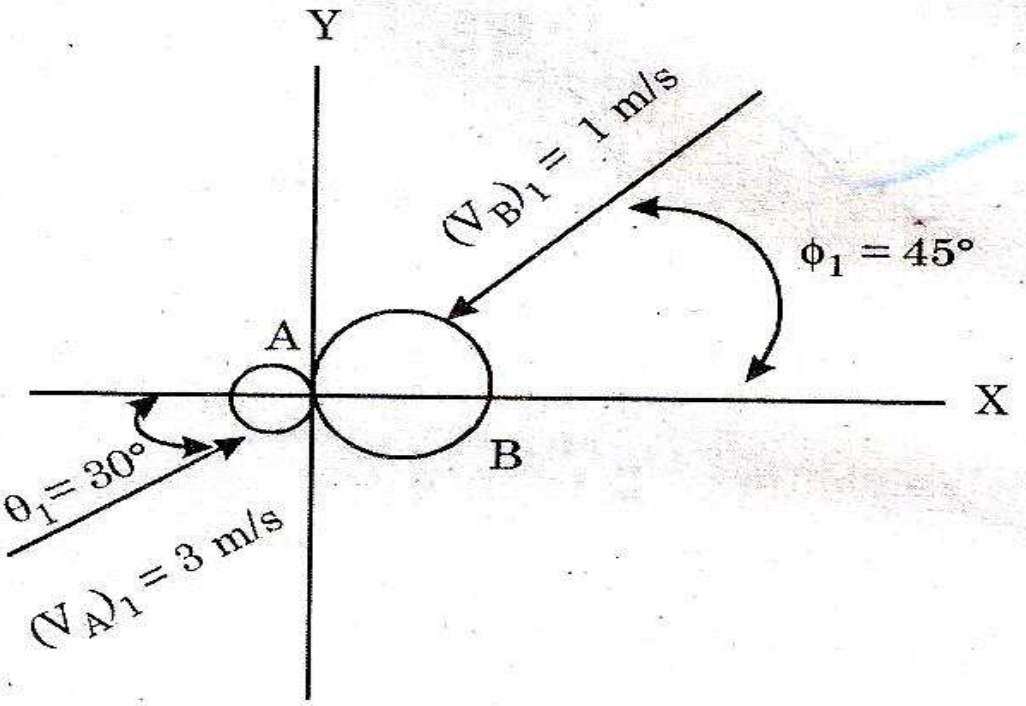
Time : 3 *Hours* *Maximum Marks :* 150

Note :— Attempt total *five* questions. Question No. 8 is compulsory. Use of quality control hand-book, calculator (non-programmable), graph-sheet is allowed. Assume missing data, if any, suitably.

1. (*a*) Two smooth disks A and B, having a mass of 1 kg and 2 kg respectively, collide with the velocities shown in the figure. If the coefficient of restitution for disks is $e = 0.75$, determine

P.T.O.

the X and Y components of the final velocity of each disk just after collision. 15



(b) A W610 × 145 cantilever beam (I = 1243 (10^6) mm^4, Z = 4079(10^3) mm^3), supported at the left end, carries a uniformly distributed load of 160 kN/m on a span of 2.5 m. Determine the maximum normal and shearing stresses in the beam. 15

2. (*a*) If the capacity of a single-plate clutch decreases by 13% during the initial wear period, determine the minimum value of the ratio of internal diameter to external diameter for the same axial load. Consider both the sides of the clutch plate to effective. 14

(*b*) Derive a relation for the displacement of mass from the equilibrium position of a damped vibratory system from first principles. 8

(*c*) Explain the different ways by which changing the die angle affects the extrusion process. 8

3. (*a*) In a hole and shaft assembly of 30 mm nominal size, the tolerances for hole and shaft are as specified below :

Hole : $30^{+0.02}_{-0.000}$ mm shaft : $30^{-0.040}_{-0.070}$ mm.

Determine :

(*i*) Maximum and minimum clearance obtainable

(*ii*) Allowance

(*iii*) Hole and shaft tolerance

(*iv*) MML shaft and hole

(*v*) The type of fit. 10

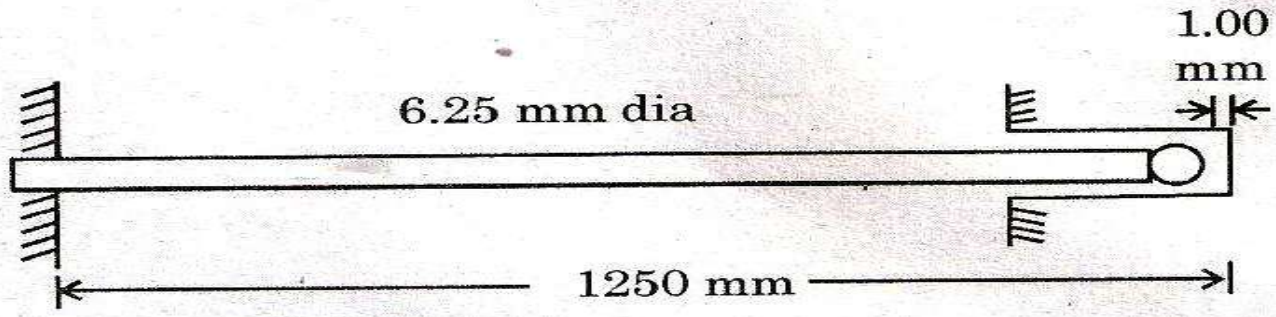
(*b*) In an orthogonal cutting operation, depth of cut t_0 = 0.0125 cm, cutting speed

V = 2 m/s, rake angle α = 10°, and the width of cut = 0.5 cm. It is observed that chip thickness t_c = 0.018 cm, F_c = 700 N and F_t = 250 N. Calculate what percentage of tool energy goes into overcoming friction at tool-chip interface. 10

(c) Explain the technical and economic reasons for taking larger rather than smaller reduction per pass in flat rolling. 10

4. (a) A steel rod, rigidly supported at one end is free to expand 1.00 mm before it makes contact with rigid support. What is the minimum temperature rise to cause buckling ? The properties of steel are; $\alpha = 11.6 \times 10^{-6}$ mm/mm°C,

$E = 200 \times 10^3$ N/mm^3. 15



(*b*) The following data relate to a circular cam operating a flat-faced follower : least diameter = 45 mm, lift = 15 mm, angle of action = 175°, speed = 500 r.p.m. If the period of acceleration of the follower is 60° of the retardation during the lift, determine the :

(*i*) Main dimensions of the cam

(*ii*) Acceleration at the main points.

What is the maximum acceleration and deceleration during the lift ? 15

5. (*a*) Use the two-phase method to solve the following LP problem :

Min. $Z = x_1 - 2x_2 - 3x_3$

Subject to $-2x_1 + x_2 + 2x_3 = 2$

and $2x_1 + 3x_2 + 2x_3 = 1$

$x_1, x_2, x_3 \geq 0$ 17

(*b*) Demand for part number 2710 was 200 in April, 50 in May, and 150 in June. The forecast for April was 100 units. With a smoothing constant of 0.20 and using first order exponential smoothing, what is the July forecast ? Is 0.20 a good choice as smoothing constant ? 7

(c) Explain the difference between direct and indirect reading linear measurements. 6

6. (a) A compound train consists of four gears. The number of teeth on gears A, B, C and D are 54, 75, 36 and 81 respectively. Gear B and C constitute a compound gear. Determine the torque on the output shaft if the gear A transmits 9 kW at 200 r.p.m. and the train efficiency is 80%. 10

(b) A steel angle 200 × 150 × 20 is to be welded to a flat plate with long side of the angle against the plate. Determine the minimum length of the weld that could carry the maximum allowable axial load. The allowable tensile strength of the weld material is 124 MPa and the allowable shearing strength is 94 MPa. Each leg of the weld is 15 mm. 10

(c) Job A, B and C arrived in alphabetical order and are given priority on a first come-first served basis. Their routings and processing times are shown below. Develop schedules for the jobs on machines using forward scheduling procedure. 10

	Job A		Job B		Job C	
Renting Sequence	Machine	Time (in hrs)	Machine	Time (in hrs)	Machine	Time (in hrs)
1	I	2	II	2	I	3
2	II	3	III	1	III	4
3	III	1	I	3	II	1

(a) Describe the similarities and differences in the action of metal working fluids in machining *Vs.* grinding operations. 10

(*b*) Explain the advantages and limitations of cold, warm and hot working of metals, respectively. 10

(*c*) Describe the engineering significance of the existence of a eutectic point in phase diagrams. 10

8. Write notes on : 6×5=30

(*a*) Virtual work

(*b*) Theories of failure

(*c*) Laws of gearing

(*d*) TQM

(*e*) Powder technology

(*f*) Pattern design.