7.(a) A flywheel of dia 1 m is rotating at 150 rpm and has to be braked by applying a vertical force P at B as in **Fig. 6**. The coefficient of friction between the steel band and the rim of the pulley is 0.35 and the flywheel is transmitting 5 hp at 100 rpm. Determine the necessary force P.

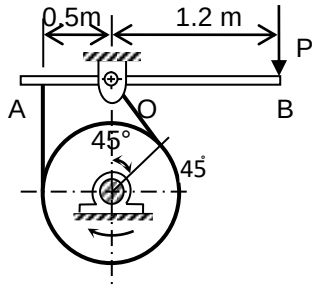

Fig. 6

(8+6+2=16)

(b) Find the maximum and minimum transmission angles for the mechanisms shown in **Fig. 7** The figures indicate the dimensions in standard units of length.

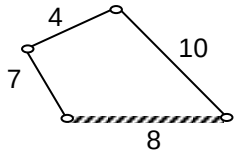

Fig.7

(c) Sketch a mechanism which is used on a test machine to produce vibration.

8.(a) What do you mean by correct steering gear? Find the mobility of Davis and Ackermann steering gear mechanism.

(6+5+5=16)

(b) In a Hooke's joint the maximum permissible variation in speed of the driven shaft is $\pm$ 8% of the mean speed. Determine the maximum permissible angle between the axes of the shafts.

(c) The distance between the steering pivot of a Davis steering gear is 1.5m. The wheel base is 2.8m. What will be the inclination of the track arms to the longitudinal axis of the vehicle if it is moving in a straight line?

Ex/Prod/T/215/2023

J A D A V P U R U N I V E R S I T Y

Bachelor in Production Engineering Examination – 2023

(Second Year – 1st Semester)

Analysis and Synthesis of Mechanisms

Time : 3 Hours Full Marks : 100

Answer Group-A(**Compulsory**), Group-B(any **one)** & Group-C(any **two)**

[52+16+32 = 100]

Group – A [**Compulsory**] [1x12+4x10=52]

1.(i) Which of the following is a lower pair? (1x12=12)

(a) Cam and follower, (b) Ball bearing, (c) Piston cylinder, (d) Tooth gear.

(ii) The ratio of tight and slack side tensions in a rope belt, v-belt:

(a) $e^{\mu\theta}$, (b) $e^{\mu\theta \mathrm{Sin}\alpha}$, (c) $e^{\mu\theta/\mathrm{Sin}\alpha}$, (d) $e^{\mu\theta \mathrm{Cos}\alpha}$, (e) $e^{\mu\theta/\mathrm{Cos}\alpha}$.

(iii) ABCD is a four-link mechanism. CD is the fixed link. AB=30 mm, BC=50 mm, CD=60 mm, and AD=70 mm. Draw and find the nature of the mechanism.

(iv) Two shafts are intersecting and vertical each other can be connected by

(a) Spur gear, (b) Herringbone gear, (c) Worm and worm wheel, (d) Bevel gear.

(v) Draw a four-bar linkage in which one revolution of the longer link causes two revolutions of the shorter link.

(vi) In a kinematic chain, a ternary joint is equivalent to : (a) One binary joint, (b) Two binary joints, (c) Three binary joints, (d) Four binary joints.

(vii) Which of the following is an inversion of single-slider crank chain?

(a) Elliptical trammel, (b) Hand pump, (c) Scotch yoke, (d) Oldham's coupling

(viii) State Grashof's law.

(ix) A Hooke's joint is used to join two shafts which are

(a) Aligned, (b) Non-parallel and Intersecting, (c) Parallel, (d) Skew.

(x) Which mechanism generates intermittent rotary motion from continuous rotary motion?

(a) Elliptical trammel, (b) Geneva mechanism, (c) Scotch yoke mechanism, (d) Crank and slotted link mechanism, (e) Toggle mechanism.

(xi) State different types of belt used to transmit motion.

(xii) Find out whether Ackermann steering gear is a double crank mechanism or a double rocker mechanism or a crank and rocker mechanism.

2.(a) Find all the inversions of the chain given in **Fig.1** and also state the nature of mechanisms. (4x10=40)

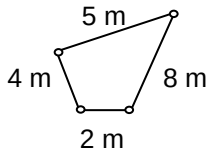

Fig.1

(b) A kinematic linkage is shown in **Fig. 2**. Find the number of degrees of freedom using Gruebler's criterion.

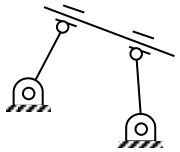

Fig. 2

(c) In a crank and slotted lever mechanism, if the lengths of the crank and the fixed links are 100 mm and 200mm respectively, what will be ratio of return time to the cutting time?

(d) Design and dimension of a mechanism that can be used to decrease pattern dimensions by 40%.

(e) The distance between two parallel shafts is 20 mm and they are connected by an Oldham's coupling. The driving shaft revolves at 240 rpm. What will be the maximum speed of sliding of the tongue of the intermediate piece along its groove?

(f) Sketch and explain the mechanism of universal drafting machine. Where is it Used?

(g) Describe with a neat sketch of a Paucellier mechanism to trace a exact straight line.

(h) Set the indexing head to mill 30 teeth gear.

(i) Sketch and explain the mechanism of parallel-crank four bar link. State the applications of this mechanism.

(j) Sketch and explain the pawl and ratchet mechanism. State the applications of this mechanism.

Group – B [Answer any **one**] [1x16=16]

3.(a) What is a cam? How are the cams classified? (4+12=16)

(b) A cam for operating the exhaust valve of an oil engine. It is required to give SHM during opening of the valve and uniform velocity during closing of the valve each of which corresponds to 120° of cam rotation. The valve must remain in the fully open position for 30° of cam rotation. The lift of the valve is 25 mm and the least radius of the cam is 40 mm which rotates at 300 rpm. The follower is a knife-edge and its line of stroke passes through the axis of the cam. Draw the profile of the cam in a suitable scale.

4.(a) In a slotted-lever type quick-return mechanism of the, the various the length of fixed link = 400 mm, the length of driving crank = 200 mm, length of the rocker arm = 700 mm, length of the connecting rod = 300 mm. The driver crank rotates at 200 rpm., From the configuration shown in **Fig. 3** determine the acceleration of the cutting tool at S.

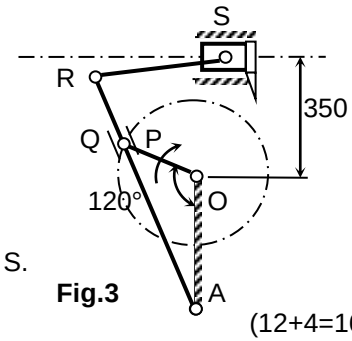

Fig.3

(12+4=16)

(b) Sketch a polar velocity diagram of an Universal coupling and mark its salient features.

Group – C [Answer any **two**] [2x16=32]

5.(b) The differential gear used in an automobile is shown in **Fig.4**. The pinion A on the propeller shaft has 18 teeth and the crown gear B has 75 teeth. The shafts P and Q form the rear axles to which the road wheels are attached. If the propeller shaft rotates at 950 rpm and the road wheel attached to axle Q has a speed of 250 rpm while taking a turn, find the speed of road wheel attached to axle P.

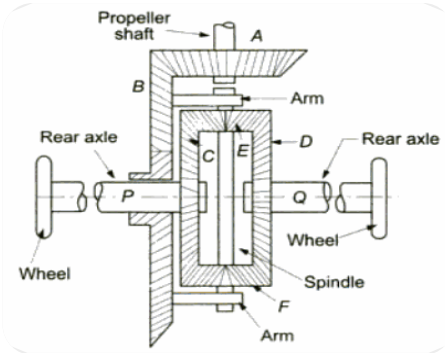

Fig.4 Differential Gear (10+6=16)

(b) The centre to centre distance between the two sprockets of a chain drive is 0.8m. The chain drive is used to reduce the speed from 220 rpm to 100 rpm. On the driving sprocket has 20 teeth and a pitch circle diameter of 0.5 m. Determine the number of teeth on the driven sprocket and pitch of the chain.

6.(a) Design a four-link mechanism to coordinate three positions of the input and the output links given by $\theta_1 = 25°$, $\theta_2 = 35°$, $\theta_3 = 50°$ and $\phi_1 = 30°$, $\phi_2 = 40°$, $\phi_3 = 60°$. (10+6=16)

(b) Find all the inversions of the slider-crank chain. State also name of the mechanisms and their applications.

[Turn Over]