WINTER– 16 EXAMINATION

Model Answer

Subject Code: 17412

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1	a)	**Attempt any SIX of the following**	**6 x 2= 12**
	(i)	**Define - Kinematic link** --Each part of a machine, which moves relative to some other part, is known as a '**kinematic link (or simply link) or element**. **Example** – any ***one*** Example of machine element, (e.g. shaft, spindle, gear, crank, belt, pulley, key etc.)	**(01 mark)** **(01 mark**
	(ii)	Different mechanism generated by single slider crank chain mechanism. **(Any four)** a) Reciprocating engine, Reciprocating compressor b) Whitworth quick return mechanism, Rotary engine, c) Slotted crank mechanism, Oscillatory engine d) Hand pump, pendulum pump or Bull engine,	**(1/2 x4 = 2 mark)**
	(iii)	Advantages of roller follower over knife edge follower a) Roller follower has less ***wear and tear*** than knife edge follower. b) Power required for driving the cam is less due to less ***frictional force*** between cam and follower	**(01 mark each)**
	(iv)	**Define slip and creep in the belt drive** **Slip --- Slip** is defined as ***insufficient frictional grip*** between pulley (driver/driven) and belt. Slip is the difference between the linear velocities of pulley (driver/driven) and belt. **Creep** ----- Uneven extensions and contractions of the belt when it passes from tight side to slack side. There is relative motion between belt and pulley surface, this phenomenon is called creep of belt.	**(01 mark each)**

	(v)	**Advantages of chain drive over belt drive** **(Any 4)** a) ***No slip*** takes place in chain drive as in belt drive there is slip. b) Occupy ***less space*** as compare to belt drive. c) ***High*** transmission **efficiency**. d) More power transmission than belts drive. *e)* Operated at ***adverse temperature*** and ***atmospheric conditions.*** f) Higher velocity ratio. g) Used for both ***long as well as short distances***.	**(1/2 x 4 = 2 mark)**
	(vi)	**Effect of centrifugal tension on power transmission** As the belt passes over the pulley with high velocity, centrifugal force is produced on the belt, which tends to act on the belt. This force tries to move the belt away from the pulley. This force is given by, $T_C = m \times V^2$ There is no effect of centrifugal tension on power transmitted.	**(02 mark)**
	(vii)	a) **Fluctuation of energy** -- The difference of maximum and minimum kinetic energy of flywheel is known as Fluctuation of energy b) **Coefficient of fluctuation of energy** -- - It is defined as the ratio of the maximum fluctuation of energy to the work done per cycle. It is denoted by $k_e = (E_1 - E_2)$/work done per cycle	**(01 mark each)**
	(viii)	Adverse effect of imbalance of rotating elements. **(Minimum two points)** a) Vibration, noise and discomfort, b) Machine accuracy get disturbed, c) Power losses, d) More maintenance	**(02 mark)**

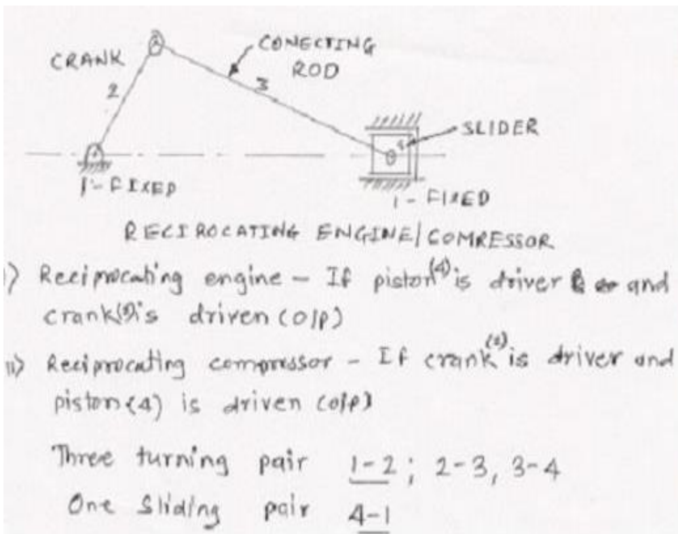
1 **b** **Attempt any TWO of the following**

i) State any **four** inversions of single slider crank mechanism. Describe **any one** with neat sketch

First --Reciprocating engine, Reciprocating compressor; **Second** -Whitworth quick return mechanism, Rotary engine, **Third--** Slotted crank mechanism, Oscillatory engine**. Fourth** Hand pump, pendulum pump. **(any four name from each inversion expected)** **02**

explain **any one** with sketch

First --Reciprocating engine, Reciprocating compressor link 1 is fixed



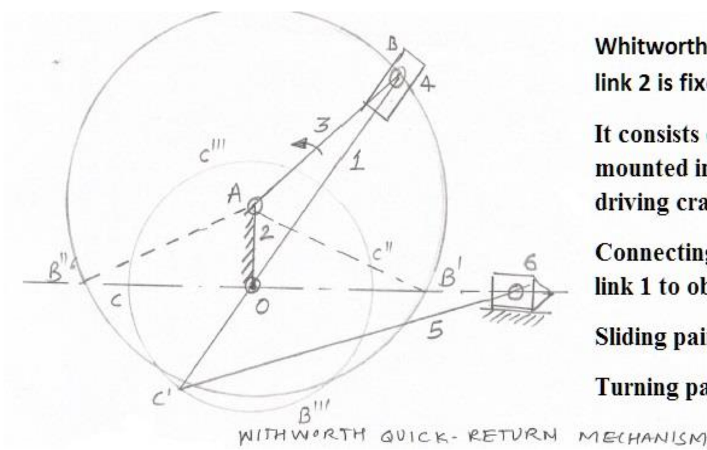
Reciprocating engine – In reciprocating engine piston/ slider (link 4) reciprocates in cylinder (fixed link 1) forming sliding pair. The connecting rod (fixed link 3)oscillates and crank rotates about fixed link 1.

Here input is from slider or piston (link 4) **02**

Reciprocating compressor – In reciprocating compressor, piston/ slider (link 4) reciprocates in cylinder (fixed link 1) forming sliding pair. The connecting rod (fixed link 3) oscillates and crank rotates about fixed link 1.

Here input is from crank (link 2).

Second -Whitworth quick return mechanism, Rotary engine. link 2 is fixed,



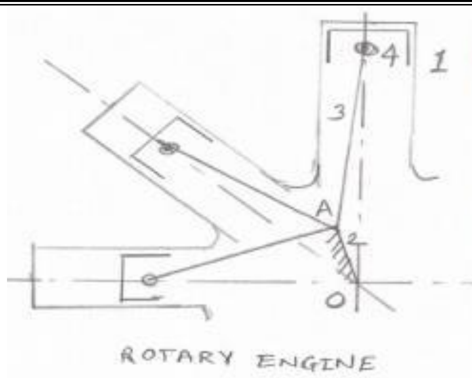
Whitworth quick return mechanism—In this mechanism link 2 is fixed

It consists of slotted lever (link 1), a slider (link 4) mounted in slotted lever, and slider is connected to driving crank (link 3).

Connecting link 5 is connected to the ram (link 6) and link 1 to obtain quick motion of ram.

Sliding pair 1-4,

Turning pair 3-4, 2-3, 1-2



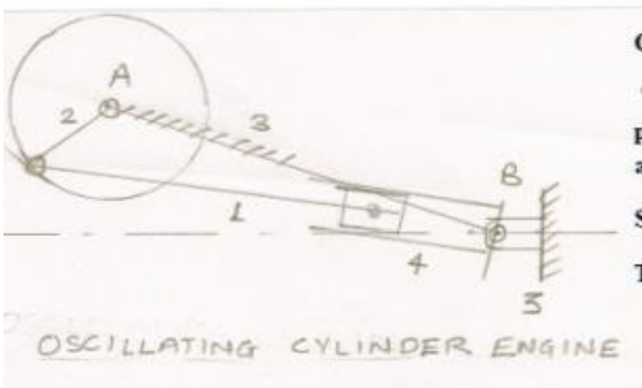
Rotary engine

Crank link is fixed (link 2), slider (link 4) is mounted in cylinder, all sliders are connected by connecting rod (link 3). The complete assembly of cylinders and crankcase rotates about center o.

Sliding pair 1-4,

Turning pair 3-4, 2-3, 1-2

Third-- Oscillatory engine**.** Slotted crank mechanism. link 3 is fixed



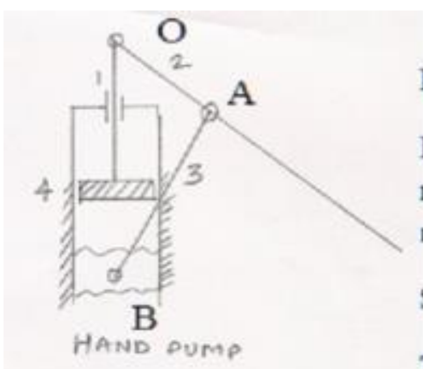
Oscillating cylinder engine

The crank (link 2) rotates; the piston is connected to piston rod (link1) reciprocates and cylinder oscillates about fixed link 3.

Sliding pair 1-4,

Turning pair 1-2 , 2-3, 3-4

Fourth Hand pump, pendulum pump. link 4 is fixed



Hand pump

Link 3 can oscillates about fixed point B on link 4, this makes end A of link 2 to oscillates about B and end O to reciprocates along the axis of the fixed link 4

Sliding pair 1-4,

Turning pair 1-2 , 2-3, 3-4

ii **Comparison of** multiplate clutch and Cone clutch

Points	**Multiplate clutch**	**Cone clutch**
Power transmission	Small power transmission for same operating condition.	Very large power/torque transmission. (Because of increase of normal force). i.e. $F_n = F/\sin\alpha$; α is semi cone angle F is axial force; F_n is normal force
Size	Larger	Smaller size or require less actuating force compared with plate clutch.

(02 marks, each point)

iii Central distance between two shafts; C = 4 Meters; = 4000 mm.

Smaller pulley diameter = d = 500 mm; Smaller pulley radius = r= 250 mm;

Larger pulley diameter = d = 700 mm; lager pulley radius = r= 350 mm;

Angle subtended by each tangent β

a) Length of open belt drive

Angle subtended by each tangent $\beta = \sin^{-1}(R-r/C) = \sin^{-1}((350-250)/4000)$

$B = 0.025$ radians

$L_O = \pi (R + r)2x\ \beta\ (R-r) + 2\ C\ x \cos\beta = 9.889$ m

$L_O = 9.889$ m

b) Length of cross belt drive

Angle subtended by each tangent $\beta = \sin^{-1}(R+ r/C) = \sin^{-1}((350+250)/4000)$

$\beta = 0.\ 01575$ radians

$L_C = \pi (R + r)2x\ \beta\ (R-r) + 2\ C\ x \cos\beta = 9.903$ m

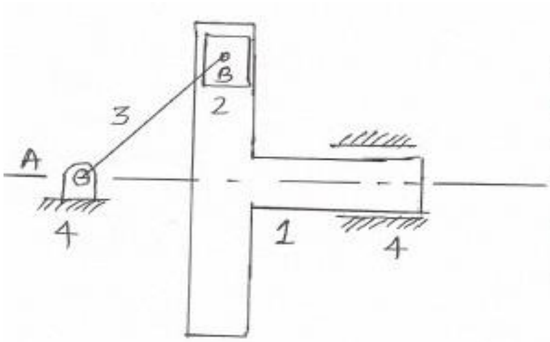
$L_C = 9.903$ m

(O2 marks each)

2 **Attempt any FOUR of the following** — **4 X4 = 16**

a **Explanation of scotch yoke mechanism with neat sketch**

2 marks sketch and 2 marks for explanation



SCOTCH YOKE MECHANISM

In scotch yoke mechanism slide block of first inversion is fixed. End B of crank (link 3) rotates about center A. Link 1 reciprocates in horizontal direction.

Sliding pair –two --- 1-4, 2-1

Turning pair – two---- 2-3, 3-4

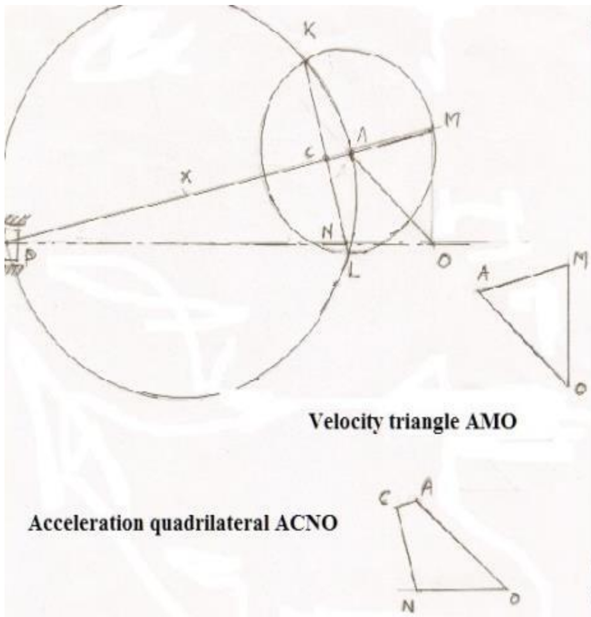
b Machine definition --A device which transforms available energy into useful work is called as machine — 01 mark

Difference of machine and structure — 03 marks

Machine	Structure
Machine transform available energy into useful work	Structure dose not transform energy in to the useful work
The link of m/c made transmit both power relative motion and forces.	The members of structure transmit forces only.
M/c can have one or more mechanism.	It does not have mechanism.
e.g. Drilling machine; Lathe machine etc.	e.g. Machine frames, Bridge etc.

c Klein's construction

a) For velocity of different links
b) For acceleration of different links



klein's construction

1) Draw the basic diagram with the angle made by crank , crank (AO) and connecting rod (AP) with dimensions and scale.
2) Extend the connecting rod upto the vertical line of the crank circle and mark intersection point M, the triangle created ΔOAM is the velocity triangle.
3) Bisect the connecting rod at X.
4) Draw the circle with radius equal to XA or XB.
5) Draw the circle with Centre as "A" and radius equal to AM.
6) Both circles will intersect each other at two points (K, L), join these two points.
7) This line will intersect the connecting rod at point "C" and line of stroke at point "N".

Quadrilateral OACN is the acceleration diagram. This is required acceleration diagram of the links

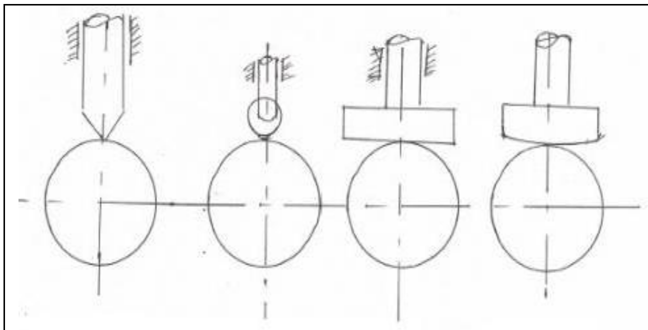
(04 marks)

2 d) Define the

Term	Definition	Mathematical/representation (optional)
Linear velocity	Rate of change of ***linear displacement*** per unit time	$V = \frac{d_x}{d_t}$ m/sec
Angular velocity	Rate of change of ***angular displacement*** per unit time	$\omega = \frac{d_\theta}{d_t}$ rad/sec
Absolute velocity	Velocity of any point with respect any point ***fixed point***	V_{ao} ; velocity of point a w.r.t. o
Relative velocity	Velocity of any point with respect to ***any other some point on the same link.***	V_{ab} ; velocity of point a w.r.t. b

(O1 marks each)

2 e Different types of follower — **04** **(02 marks each; any two sketches with explanation)**



Knife edge follower – Simple in construction, sliding motion between cam and follower.

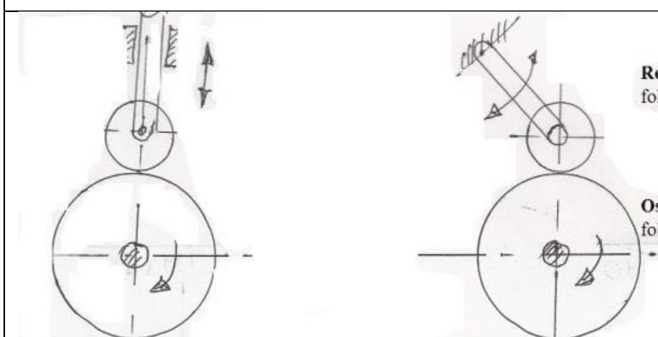
Roller follower- Less wear and tear. Rolling motion between cam and follower.

Flat faced follower- High wear and tear, high surface stresses.

Spherical follower- High wear and tear, high surface stresses are reduced by spherical follower.

Knife edge follower (Figure a) Roller follower (Figure b) Flat faced follower (Figure c) Spherical follower (Figure d)

According to type of shape



Reciprocating follower- Cam rotates and follower reciprocates.

Oscillating follower- Cam rotates and follower is oscillating.

Reciprocating follower Oscillating follower

According to type of motion of follower

Radial follower – The motion of follower passes through the axis of the cam.

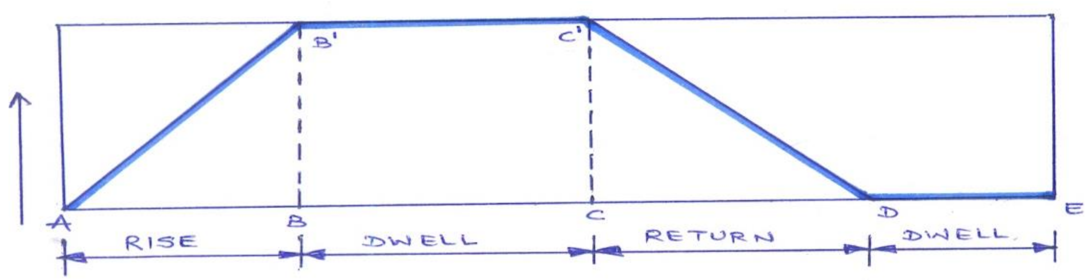
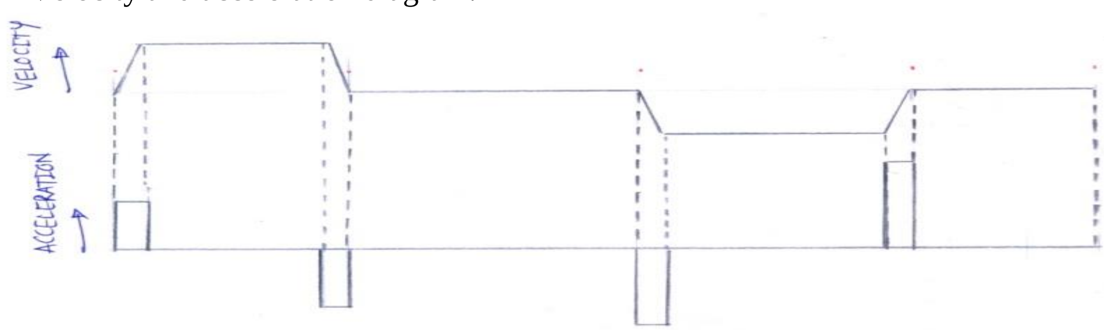
Offset follower – The line of action of follower is away (eccentric) from axis of the cam

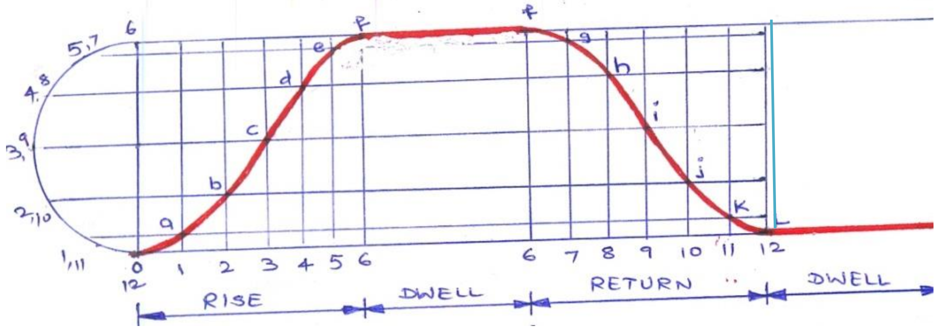
RADIAL FOLLOWER OFFSET FOLLOWER

According to line of motion of follower

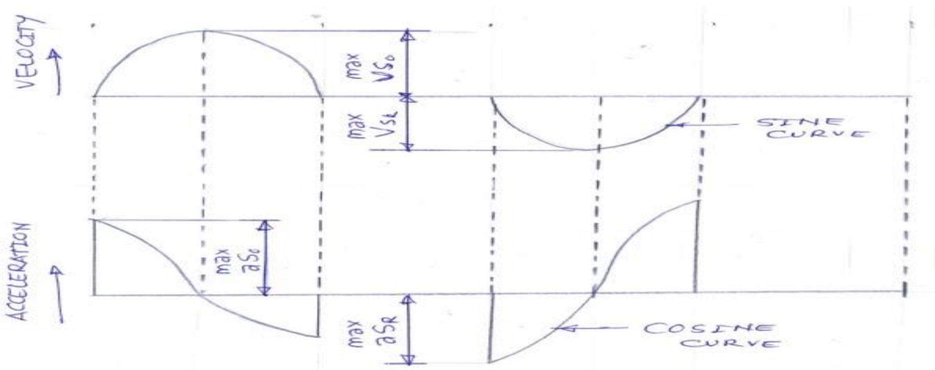
2 f Flat belt speed = V = 600 m/min = 600/60 m/sec = 10 m/sec;

Power transmitted = P = 4 kW ; Coefficient of friction =μ = 0.3;
Angle of lap = θ =160^0

		Belt tension ratio $= T_1/T_2 = e^{\mu\theta} = e^{0.3(160 \times \pi/180)} =$ **2.31;** T_1/T_2 **= 2.31** $T_1/T_2 = 2.31$; **$T_1 = T_2 \times 2.311$--------------------------------(1)** $P = (T_1 - T_2) \times V$; **--------------------------------(2)** $P = (T_2 \times 2.31 - T_2) \times 10$; Putting value of power P = 4 kW $4 \times 1000 = (T_2 \times 2.31 - T_2) \times 10$**;** $T_2 = 305.34$ N; $T_1 = 705.34$N; $T_{maximum} = T_1 = 705.34$N	**01 mark** **1 mark for each step = 03 marks**
03	a.	**i) uniform velocity.** displacement diagram:  Velocity and acceleration diagram:  **ii) simple harmonic motion.** Displacement diagram:	**04 mark**

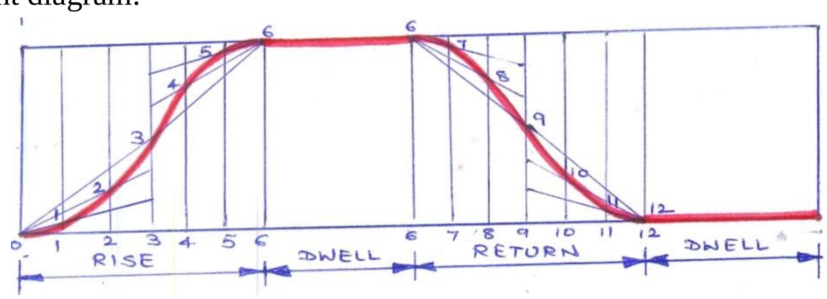


Velocity and acceleration diagram:

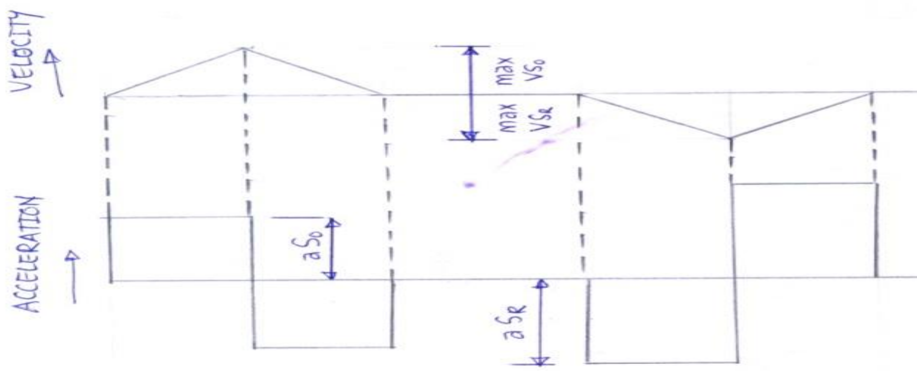


iii) uniform acceration and retardation.

Displacement diagram:



Velocity and acceleration diagram:



b.

Relative Velocity Method.

Given Data:

Crank = 0.5m

Connecting rod=2m

N= 180 rpm

$\Theta = 45^0$

A) Space diagram:

Scale:

1cm= 0.25m

01

$$\omega = \frac{2\Pi N}{60}$$

$$\frac{2\Pi X 180}{60}$$

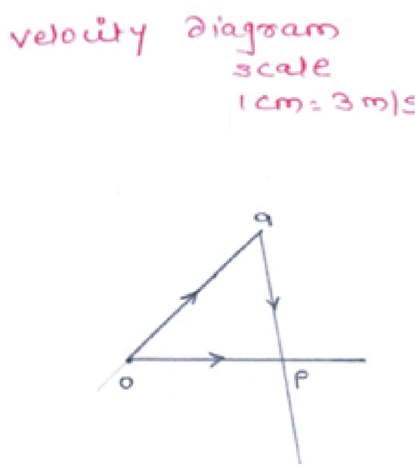
ω = 18.84 rad/s

Calculations:

1)V_{OA}= rω

= 0.5 X 18.84

V_{OA} = 9.42 m/s ….1 mark 01



B)Velocity diagram:

Scale:

1 cm=3m/s

2) Velocity of piston:

Vp= L(op) X scale

=2.8 X3

Vp=8.4 m/s …..ans 01

3) Angular velocity of connecting rod:

$\omega = \frac{Vap}{length\ of\ AP} = \frac{l(ap) X\ Scale}{2} = \frac{2.2X3}{2}$

ω= 3.3 rad/sec…..ans 01

03 c.

Sr. no.	Parameters	Cross belt drive	Open belt drive
1	Velocity ratio	High velocity ratio	Low velocity ratio
2	Direction of driven pulley	Rotated in same direction as the driving as the driving pulley	Rotated in the opposite direction to the driving pulley
3	Application	Sawmills, buck saws	Conveyors, electrical generator
4	Length of belt drive	$L = \Pi(r_1+r_2)+2C+\frac{(r_1-r_2)^2}{C}$	$L = \Pi(r_1+r_2)+2C+\frac{(r_1+r_2)^2}{C}$

1 mark for each point.

d.

SR. No.	Name of brake	Applications
1	Band brake	Drums and chain saws, Railway braking system.
2	Disc brake	Any rotating shaft, motor cycles
3	Internal expanding brake	All type of light vehicles(motor cars, 2 wheelers),light truks
4	External shoe brake	Railway coach, electric cranes

1 mark for any 1 application

e.

$\Theta_1 = 0^0$ $\Theta_2 = 60^0$ $\theta_3 = 1500$

Resolving Horozontally,

$\sum H = m_1r_1\cos\theta_1 + m_2r_2\cos\theta_2 + m_3r_3\cos\theta_3$

$= 200\cos o^o + 500\cos 60^{0+} 225\cos 150^0$

=255.14 ……………………**…1 mark**

Resolving vertically,

$\sum V = m_1r_1\sin\theta_1 + m_2r_2\sin\theta_2 + m_3r_3\sin\theta_3$

$= 200\sin o^o + 500\sin 60^0 + 225\sin 150^0$

$^=$545.51 …………………..**1mark**

∑H=01

∑V=01

Mb=01

Θ'=01

R= $\sqrt{\sum H^2 + \sum V^2}$

= $\sqrt{255.14^2 + 545.51^2}$

R=602.22

R= $m_b r_b$=602.22

m_bX 30=602.22

mb=602.22/30

mb=20.07 Kg

Angle of balancing mass,

$\Theta = \tan^{-1}\left(\frac{\sum V}{\sum H}\right)$

$= \tan^{-1}\left(\frac{545.51}{255.14}\right)$

$\Theta = 64.93^0$

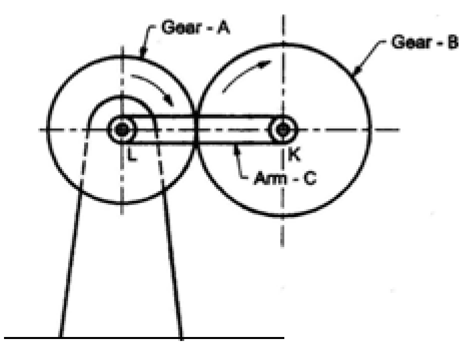
$\Theta' = 64.93^0 + 180 = 244.93^0$

f

In single, Compound reveted gear trains the axis on which gears are mounted are fixed relative to each other. In case of epicyclic gear train the axis of shaft on which the gears are mounted may have relative motion between them. **02**

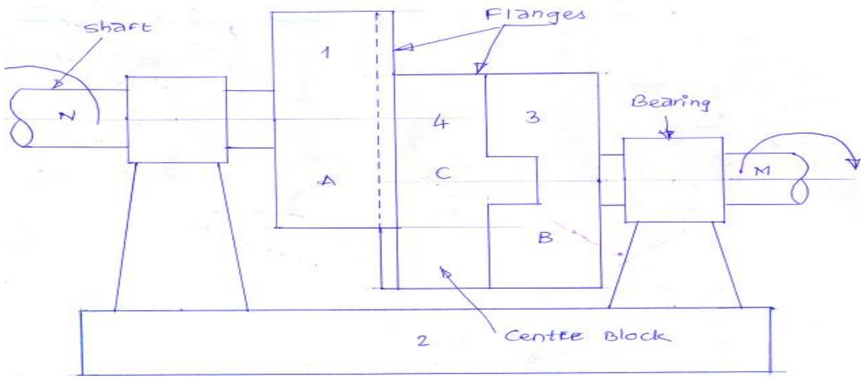
Gear ‘A’ and arm ‘C’ rotate about fixed axis. The gear ‘B’ rotates about axis ‘S’ and also about arm ‘C’ which in turn revolves about fixed axis through ‘R’. The gear ‘A’ and ‘B’ are simple gear train when arm ‘C’ is fixed. **()**

02



4. a. Power transmission in belt drive depends on angle of lap and frictional grip between belt and pulley. As slack side is at upper side angle of lap and grip increases. **04 marks**

b.



Oldham's coupling is used for connecting too parallel shafts whose axis are a small distance a part the shafts are coupled in such a way that if one shaft rotates the other shaft also rotate at same speed.

This mechanism is obtained by fixing link 2 which is shown in fig. The shafts to be connected have two flanges namely link 1 and links 3 are rigidly fasten at their end by pair with link2. The link 4 is a single part but acting in two ways so link 4 form two sliding pair.

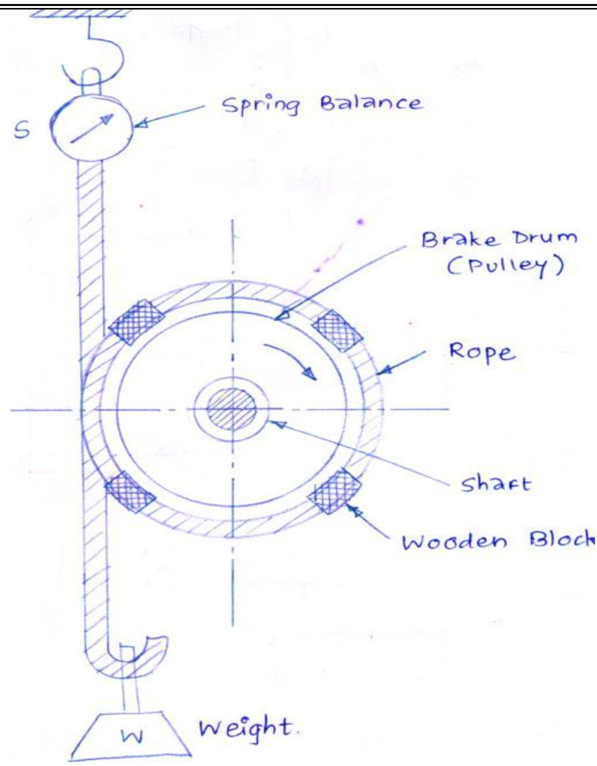
When the driving shaft N rotates the flange 'A' causes the intermediate piece (Centre Block) to rotate at same angle through which flange has rotate and it further rotate the flange B (link 3) at same angle and thus shaft M rotates.

Fig.2marks+ 2 marks explanation.

4. c.

Sr. No.	Flywheel	Governor
1	The flywheel stores the energy and gives up the energy whenever required during cycle.	It regulates the speed by regulating the quantity of charge of prime mover.
2	It has no control over the quantity of working fluid.	Governor takes care of quantity of working fluid.
3	It regulates the speed during one cycle only.	It regulates the speed over period of time.
4	It is not essential element for every prime mover.	It is an essential element of a prime mover.
5	It is used in toys, IC engine, hand watches.	It is used in automobile vehicles.

1 mark each for any 4 points

	d.		Fig.2marks 2 marks explanation.

It consist of two or more ropes wound around flywheel on ream of pulley rigidly fixed to the shaft of an engine. The upper end of rope is attached to a spring balance while the lower end of the rope is kept in position by applying dead weight.

To prevent slipping of rope over flywheel wooden blocks are used which is placed at intervals around the circumference of flywheel.

The operation of brake the engine is made to run at constant speed the frictional torque due to rope must be equal to torque being transmitted by the engine. Net brake load = W – S.

Therefore, frictional torque due to ropes = torque transmitted by engine at constant speed.

Brake power (P) = Torque transmitted into angular speed of engine.

If diameter of rope is neglected then, $P = \frac{(W-S)\pi DN}{60}$

Applications:-It is commonly used for measuring brake power of the engine.

e.

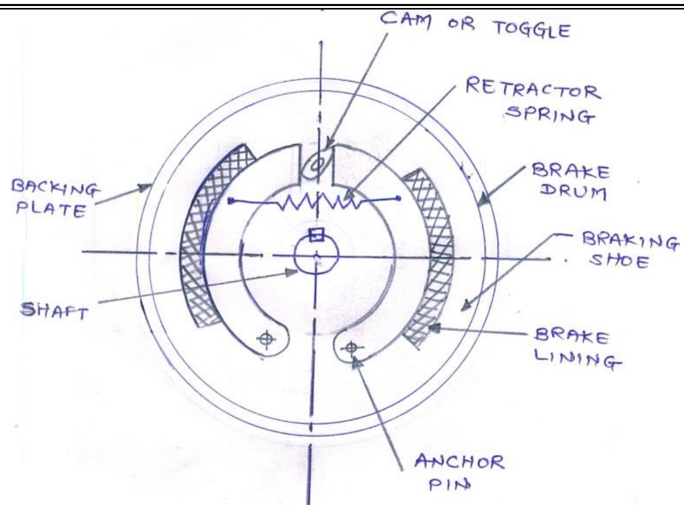


Fig.2marks 2 marks explanation

fig. shows a mechanical brake or internal expanding brake used in automobile vehicles.

Construction:-

1) It consists of two semi-circular brake shoe having friction lining on their outer surface.
2) Brake shoes are hinged to back plate at lower end by an anchor pin while other end rest on cam.
3) The cams turns or actuate by camshaft passes through the hole in back plate.
4) The camshaft can be operated by brake pedal through linkage.
5) The outer portion of brake is brake drum which encloses the complete brake msm and protect it from dust and moisture.

Working:-

1) When break pedal is pressed the cam turn to outwear by expanding the brake shoe against the retractor spring force.
2) The friction lining comes in contact with drum and causes friction between them.
3) This force of friction oppose the direction of motion and by reducing the speed or stop vehicle.
4) When brake pedal is released the retracting spring pull the brake shoe inward which turn the cam and brakes are released.

f. m = Mass attached to shafts, r = Distance of CG from axis of rotation.

Consider mass ‘m’ is attached to rotating shaft at a radius are then the centrifugal force exerted by mass ‘M’ on the shaft is **$F_c = Mw^2R$**

Where,

W = Angular velocity of shaft

R = Distance of CG from axis of rotation

M = Mass attached to shaft.

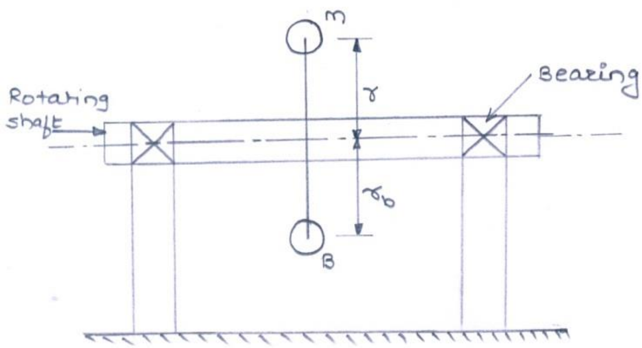


Fig.1marks 3 marks explanation

Due to continuous rotation of shaft the centrifugal force developed will be continuously changing its direction. It will cause bending moment on shaft.

To counter act the effect of centrifugal force the balance weight may be introduced in same plane of rotation. This balance weight should be attached it will result in exactly equal but opposite centrifugal force to that of disturbing weight 'M'.

The balanced centrifugal force is given by $Fb = mbw^2R_b$

For balancing the shaft – $Mw^2R = mbw^2R_b$.

Q.5 Attempt any TWO [16]

a) Radius of crank , r=100 mm = 0.1m speed. N= 600 rpm ,ω= 2πN/60=62.83 rad/sec

Length of connecting rod, l=400 mm=0.4m (40 mm is printing mistake)

Obliquity ratio, n=l/r =400/100= 4, Crank angle ,θ= 45^o

Velocity of slider Vp= $\omega r(\sin\theta + \frac{\sin 2\theta}{2n})$ =5.225 m/s 2

Acceleration of slider fp = $\omega^2 r(\cos\theta + \frac{\cos 2\theta}{n})$ =279.15 m/s² 2

Angular velocity of connecting rod $\omega_{pc} = (\omega \cos\theta)/n$ = 11.107 rad/sec 2

Angular acceleration of connecting rod $\alpha_{pc} = (-\omega^2 \sin\theta)/n$ = -697.89 rad/sec² 2

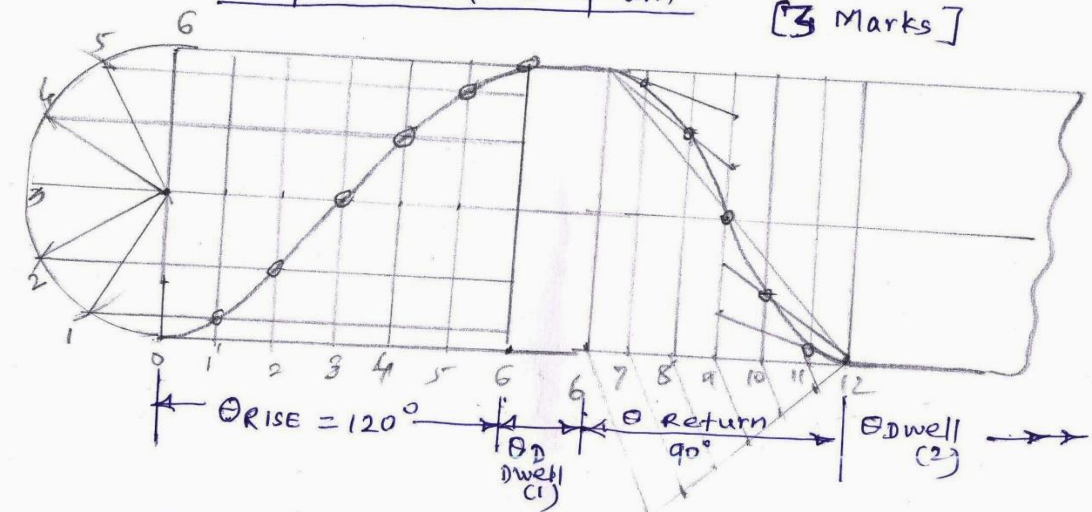
[Note- If student has taken l=40,(due to printing mistake in QP) which is practically not possible, but values of answers in that case will be Vp=12.29 m/s ;fp= 279.15 m/s²; ω_{pc}=111.07 rad/sec; α_{pc}=6978.86 rad/s² , which may be acceptable.]

b.

Q5(b) Cam profile

Data – Follower rise – 120° (SHM) (5 cm)
Dwell – 30°, Return – 90° (Uniform Acc^n & Retardation)
Min. radius of Cam – 5 cm, roller dia = 2 cm,
Offset of follower – 2 cm

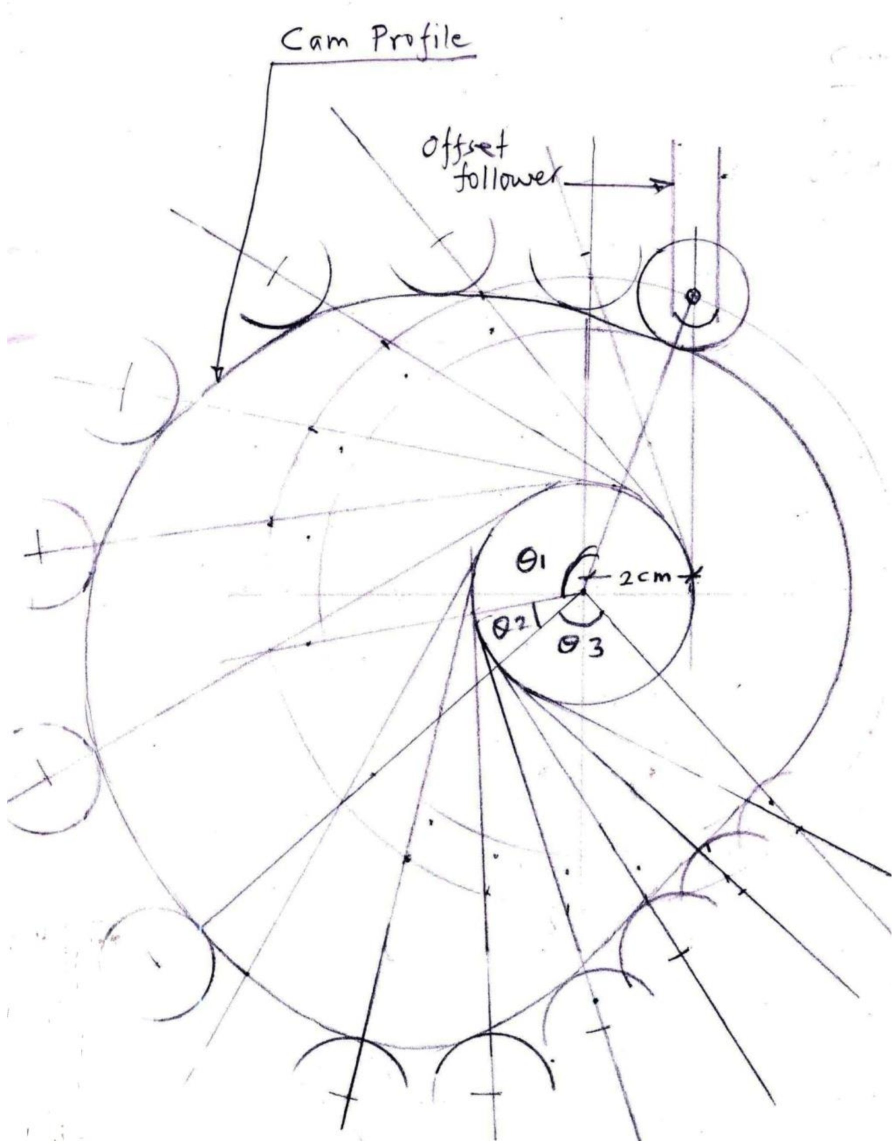
Displacement Diagram [3 Marks]



Cam profile [5 Mark]

Displacement diagram …..3 Marks

Cam profile …….5 Marks



c

Band and block brake

No. of blocks n=14 ; θ= 16° ; $\mu = 0.3$ braking force= 300N

$\frac{Tn}{To} = [\frac{1+\mu \tan\frac{\theta}{2}}{1-\mu \tan\frac{\theta}{2}}]^n$ =3.26 .... 4 M

To X 10=300 X 60 ; To =1800 N ; Tn = 1800 X 3.26 = 5868 N Let r_b = radius of brake drum (Not given). If we consider it as 10 cm,

r_b = (5868-1800) X 0.1 =406.8 N m 4M

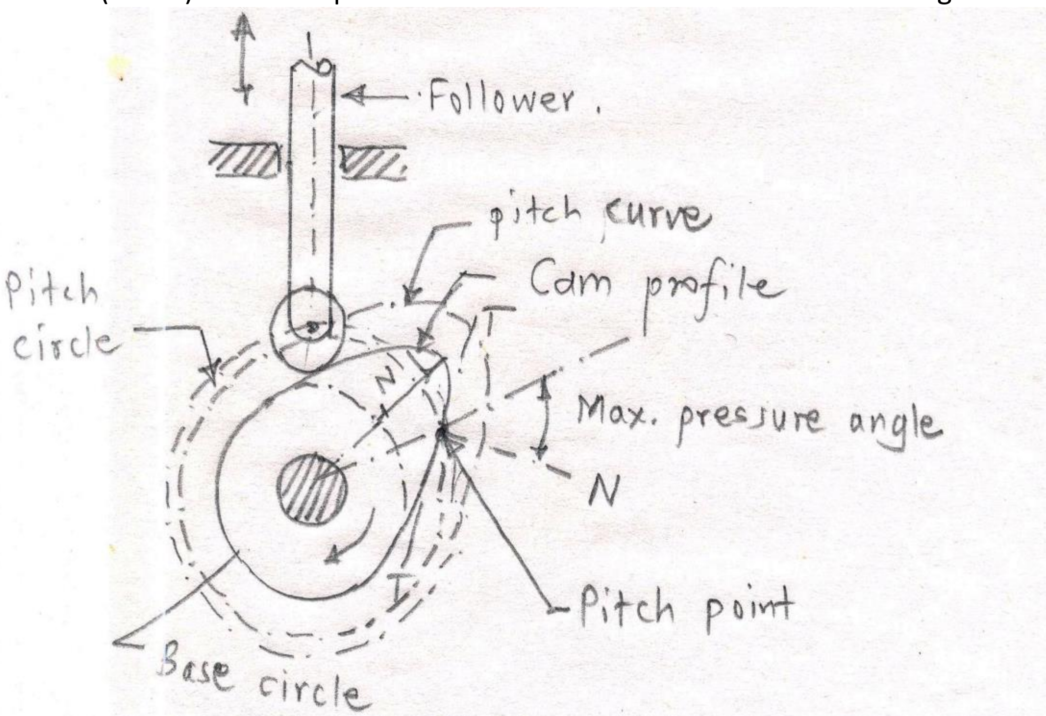
6

a.

Attempt any TWO .....[16]

a) (i) Define ...(.1 for each definition with sketch)

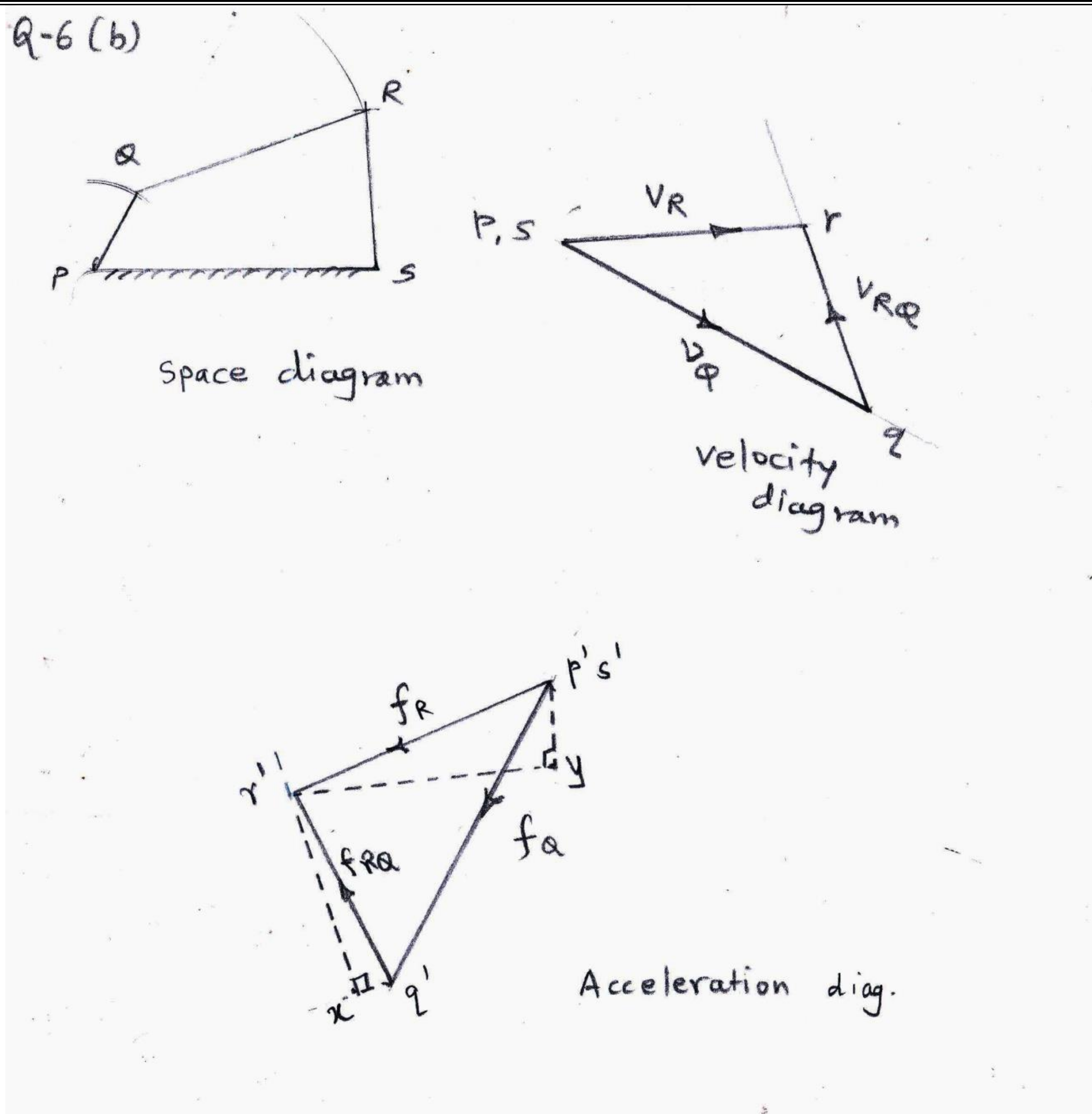
(1) Pitch circle- Circle drawn from centre of cam through pitch points
(2) Pressure angle- Angle between direction of follower motion and normal to pitch curve
(3) Stroke- Maximum travel of follower from its lowest position to top most position
(4) Module –(Gears) – Ratio of pitch circle diameter in mm to No. of teeth on gear



(ii) Differentiate (Any four points ; 4 X 1 =4 Marks)

DISC BRAKE	DRUM BRAKE
It uses disc shaped rotors	It uses cylindrical drum
It uses a clamp called caliper to hold the friction 'pads' against rotor disc	It uses expanding hydraulic cylinder to press the friction material (shoes) against the inside of rotating drum.
Good braking even at high temperature	Reduced performance at high temp.
Better heat dissipation	Slower heat dissipation
Fast braking, better braking force	Slow braking
Cost is more	Cheaper than disc brake
Generally Used for modern bikes, cars	Used for trucks, bus, scooter

b. (b) Four bar chain Velocity Diagram ....2M ; Acceleration Diagram 2M



Calculations-

$V_{QP} = \omega_{QP}$ X PQ =10 X 0.0625 = 0.625 m/s

From Velocity diagram,

By measurement, V_{RQ} =0.333 m/s,; $\omega_{QR} = V_{RQ}/RQ$ =0.333/0.175 =1.9 rad/s (Anti clockwise)…1M

By measurement, V_{RS} =0.426 m/s,; $\omega_{RS} = V_{RS}/SR$ =0.426/0.1125 =3.78 rad/s (clockwise)…..1M

Find out radial acceleration of each link by using formula -V^2/length of link

Fr_{QP} =6.25 m/s^2 ; fr_{RQ} = 0.634 m/s^2 ; fr_{RS} = 1.613 m/s^2

From acceleration diagram, measure all tangential components (ft)

Angular acceleration of link QR , α_{QR} = ft RQ /QR =4.1/0.175= 23.43 rad/s^2 (Anti clockwise)…1M

Angular acceleration of link RS , α_{RS}= ft RS /SR =5.3/0.1125= 47.1 rad/s^2 (Anti clockwise) …1M c

Q6 : (C) Foot Sep bearing

$W = 15$ KN, $N = 100$ rpm, $r = 7.5$ cm $= 0.075$ m

(i) Considering uniform pressure theory

Torque, $T = \frac{2}{3} \mu W R$ N-m

$= \frac{2}{3} \times 0.05 \times 15 \times 10^3 \times 0.075$

$= 37.5$ Nm ----- [2M]

Power lost,

$P = \frac{2 \pi N T}{60 \times 1000} = 0.393$ KW --- [2M]

(ii) Considering Uniform wear theory

Torque, $T = \frac{1}{2} \mu W R$ N-m

$= \frac{1}{2} \times 0.05 \times 15 \times 10^3 \times 0.075$

$= 28.1$ N-m ---- [2M]

Power lost,

$P = \frac{2 \pi N T}{60 \times 1000} = 0.294$ KW -- [2M]