മീറ്റിംഗ് മിനിട്സ് (24/01/24)

5021(21)

സമയം.11.00

വേദി: ജോയിൻറ് കൺട്രോളറുടെ ചേമ്പർ

പങ്കെടുത്തവർ

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3. ശ്രീ.സനൽകുമാർ.എ,അസിസ്റ്റൻറ് കൺട്രോളർ
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8 ശ്രീ.ഷറഫുദീൻ.എ,സിസ്റ്റം അനലിസ്റ്റ്

1.Decision taken by the JCTE office on 23/01/24, based on the complaints received from students from various Polytechnic colleges in connection with the Diploma Examination November 2023 and the recommendations of expert committee from different departments.

OUT OF SYLLABUS QUESTION GUIDELINES

R.21	5043D	Part.B Question -8	3 mark
		Part C Question V	7 mark
R.21	3042	Part.C Question No.IV	4 mark
		Part C Question VII	2 mark
		Part C Question X	2 mark
R.21	3051	Part.C Question VI	7 mark
R.21	5021	Part B Question 9	3 mark

R.21	3055	Question III	25 marks
R.21	3044	Part.B Question 8	3 mark
R.21	3033	Part C Question 13	7 mark
R.15	5182	part B question II	Students who have drawn the site plan in the 1:200, 1:400 and 1:800 scales can be considered eligible for getting the marks they deserve .

The above mentioned questions are out of syllabus as recommended by the expert committee. Hence, following guidelines shall be used to calculate the mark/grade of the students who had tried to attend the above specific questions.

a) Calculate the percentage of marks obtained by the student considering the total marks excluding the marks of out of syllabus questions.

b) Then, the proportionate marks of out of syllabus questions shall be calculated based on the above obtained percentage.

c) Marks obtained in the above cases shall be added to get actual marks admissible to the student.

2. 25.01.2024 -ന് ആരംഭിക്കുന്ന ഡിപ്ലോമ പരീക്ഷ മൂല്യനിർണ്ണ ക്യാമ്പിൻറ പ്രവർത്തനം സംബന്ധിച്ച് കമ്മിറ്റി ചർച്ച ചെയ്യുകയും ക്യാമ്പ് ആഫീസർമാർക്ക് നിർദ്ദേശങ്ങൾ നൽകുന്നതിന് സർക്കുലർ അയയ്ക്കുവാൻ D2 സെക്ഷൻ സീനിയർ ക്ലർക്ക് ശ്രീ.അനൂപിനെ ചുമതലപ്പെടുത്തുകയും ചെയ്തു.

3. ക്യാമ്പുകളുടെ സുഗമമായ നടത്തിപ്പിനായി വിവിധ മൂല്യനിർണ്ണയ ക്യാമ്പുകൾ സന്ദർശിക്കുവാൻ JCTE, DCTE, ACTE, TECHNICAL OFFICER എന്നിവരെ നിയോഗിക്കുവാൻ തീരുമാനിച്ചു.

4.SBTE സോഫ്റ്റവെയറിൻറ സെക്യൂരിറ്റി ആഡിറ്റ് ചെയ്യുന്നതിന് JCTE ആഫീസിൽ ലഭിച്ചിട്ടുള്ള പ്രപ്പോസലുകൾ പരിശോധിച്ച് തീരുമാനം എടുക്കുന്നതിന് NIC യ്ക്ക് കത്ത് അയ്ക്കുവാൻ തീരുമാനിച്ചു.

CONTROLLER OF TECHNICAL EXAMINATIONS * TRIVANDRUM * Govt. Of Kerala Dept. Of Techl Edn.

ജോയിൻറ് കൺട്രോളർ

(2) Set A (11) Nov 23

Scoring Indicators

COURSE NAME : DESIGN OF MACHINE ELEMENTS

COURSE CODE : 5021

5021(21)

QID : 2109230028

PART A

I. Answer all the following questions in one word or sentence.

(9 x 1 = 9 Marks)

Max. marks

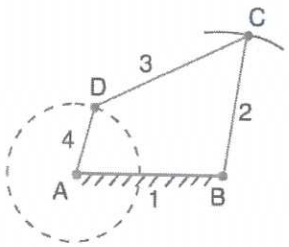
Q.No.	Scoring Indicators	Split score	Sub Total	Total score
	PART A			9
I	Kinematic Link (Link)	1	1	
2	Completely Constrained Motion	1	1	
3	Lap Joint	1	1	
4	Bending Stress	1	1	
5	Shear Stress	1	1	
6	Sunk Key	1	1	
7	Flat Saddle Key	1	1	
8	Lift (Stroke)	1	1	
9	Open Belt Drive	1	1	
	PART B			24
1	**Ultimate Stress**: The stress, which attains its maximum value is known as ultimate stress. It is defined as the largest stress obtained by dividing the largest value of the load reached in a test to the original cross-sectional area of the test piece **Yield stress:** If the material is stressed beyond point the elastic limit, the plastic stage will reach i.e. on the removal of the load, the material will not be able to recover its original size and shape. Where the strain increases at a faster rate with any increase in the stress. At this point, the material yields before the load and there is an appreciable strain without any increase in stress. The stress corresponding to yield point is known as yield point stress. **Factor of Safety:** It is defined, in general, as the ratio of the maximum stress to the working stress. Mathematically, Factor of safety = Maximum stress Working or design stress	1+1+1	3	

2	1. It should have high strength. 2. It should have good machinability. 3. It should have low notch sensitivity factor. 4. It should have good heat treatment properties. 5. It should have high wear resistant properties.	Any three	3	
3	1. Shear stresses due to the transmission of torque (i.e. due to torsional load). 2. Bending stresses (tensile or compressive) due to the forces acting upon machine elements like gears, pulleys etc. as well as due to the weight of the shaft itself. 3. Stresses due to combined torsional and bending loads.	1+1+1	3	
4	1. Sunk keys 2. Saddle keys 3. Tangent keys 4. Round keys 5. Splines.	Any three	3	
5	1. Watt Governor 2. Porter Governor 3. Proell Governor 4. Hartnell Governor 5. Hartung Governor 6. Wilson – Hartnell Governor 7. Pickering Governor	Any three	3	
6	The difference between the maximum and minimum speeds during a cycle is called the maximum fluctuation of speed. The ratio of the maximum fluctuation of speed to the mean speed is called the coefficient of fluctuation of speed.	3	3	
7	1. It should be easy to connect or disconnect. 2. It should transmit the full power from one shaft to the other shaft without losses. 3. It should hold the shafts in perfect alignment. 4. It should reduce the transmission of shock loads from one shaft to another shaft. 5. It should have no projecting parts	Any three	3	
8	1. To provide for the connection of shafts of units that are manufactured separately such as a motor and generator and to provide for disconnection for repairs or alternations. 2. To provide for misalignment of the shafts or to introduce mechanical flexibility. 3. To reduce the transmission of shock loads from one shaft to another. 4. To introduce protection against overloads.	Any three	3	

9	1. Compressive strength 2. Fatigue strength 3. Comformability. 4. Embeddability 5. Bondability 6. Corrosion resistance 7. Thermal conductivity 8. Thermal expansion	Any three	3	
10	1. It transmits exact velocity ratio. 2. It may be used to transmit large power. 3. It may be used for small centre distances of shafts. 4. It has high efficiency. 5. It has reliable service. 6. It has compact layout.	Any three	3	
	PART C			42
11	According to the type of relative motion between the elements. The kinematic pairs according to type of relative motion between the elements may be classified as discussed below: **(a) Sliding pair:** When the two elements of a pair are connected in such a way that one can only slide relative to the other, the pair is known as a sliding pair. The piston and cylinder, cross-head and guides of a reciprocating steam engine, ram and its guides in shaper, tail stock on the lathe bed etc. are the examples of a sliding pair. A little consideration will show, that a sliding pair has a completely constrained motion. **(b) Turning pair:** When the two elements of a pair are connected in such a way that one can only turn or revolve about a fixed axis of another link, the pair is known as turning pair. A shaft with collars at both ends fitted into a circular hole, the crankshaft in a journal bearing in an engine, lathe spindle supported in head stock, cycle wheels turning over their axles etc. are the examples of a turning pair. A turning pair also has a completely constrained motion. **(c) Rolling pair:** When the two elements of a pair are connected in such a way that one rolls over another fixed link, the pair is known as rolling pair. Ball and roller bearings are examples of rolling pair. **(d) Screw pair:** When the two elements of a pair are connected in such a way that one element can turn about the other by screw threads, the pair is known as screw pair. The lead screw of a lathe with nut, and bolt with a nut are examples of a screw pair. **(e) Spherical pair:** When the two elements of a pair are connected in such a way that one element (with spherical shape) turns or swivels about the other fixed element, the pair formed is called a spherical pair. The ball and socket joint, attachment of a car mirror, pen stand etc., are the examples of a spherical pair.	Fig – 2 Marks Expln – 5 Marks	7	

1. Four bar chain or quadric cyclic chain:

The simplest and the basic kinematic chain is a four bar chain or quadric cycle chain, as shown in Fig. It consists of four links, each of them forms a turning pair at A, B, C and D. The four links may be of different lengths. According to Grashof 's law for a four-bar mechanism, the sum of the shortest and longest link lengths should not be greater than the sum of the remaining two link lengths if there is to be continuous relative motion between the two links. A very important consideration in designing a mechanism is to ensure that the input crank makes a complete revolution relative to the other links. The mechanism in which no link makes a complete revolution will not be useful. In a four-bar chain, one of the links, in particular the shortest link, will make a complete revolution relative to the other three links, if it satisfies the Grashof 's law. Such a link is known as crank or driver. In Fig, AD (link 4) is a crank. The link BC (link 2) which makes a partial rotation or oscillates is known as lever or rocker or follower and the link CD (link 3) which connects the crank and lever is called connecting rod or coupler. The fixed link AB (link 1) is known as frame of the mechanism.



IV

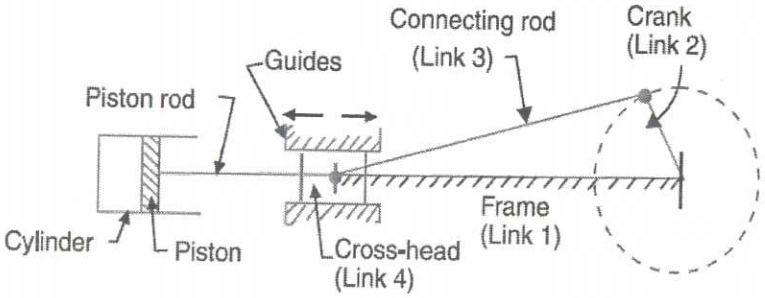
Fig – 3 Marks

Expln – 4 Marks

7

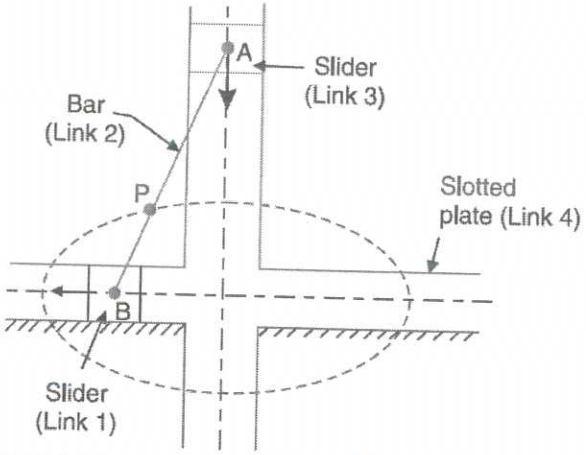
2. Single slider crank chain:

A single slider crank chain is a modification of the basic four bar chain. It consists of one sliding pair and three turning pairs. It is, usually, found in reciprocating steam engine mechanism. This type of mechanism converts rotary motion into reciprocating motion and vice versa. In a single slider crank chain, as shown in Fig, the links 1 and 2, links 2 and 3, and links 3 and 4 form three turning pairs while the links 4 and 1 form a sliding pair. The link 1 corresponds to the frame of the engine, which is fixed. The link 2 corresponds to the crank; link 3 corresponds to the connecting rod and link 4 corresponds to cross-head. As the crank rotates, the cross-head reciprocates in the guides and thus the piston reciprocates in the cylinder.



3. Double slider crank chain.

A kinematic chain which consists of two turning pairs and two sliding pairs is known as double slider crank chain, as shown in Fig. We see that the link 2 and link 1 form one turning pair and link 2 and link 3 form the second turning pair. The link 3 and link 4 form one sliding pair and link 1 and link 4 form the second sliding pair.



1. Beam engine (crank and lever mechanism).

A part of the mechanism of a beam engine (also known as crank and lever mechanism) which consists of four links, is shown in Fig. In this mechanism, when the crank rotates about the fixed centre A, the lever oscillates about a fixed centre D. The end E of the lever CDE is connected to a piston rod which reciprocates due to the rotation of the crank. In other words, the purpose of this mechanism is to convert rotary motion into reciprocating motion.

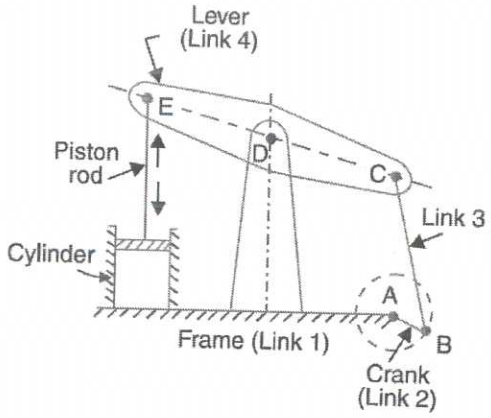


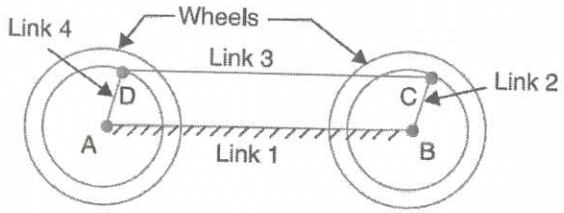
Fig – 3 Marks

Expln – 4 Marks

7

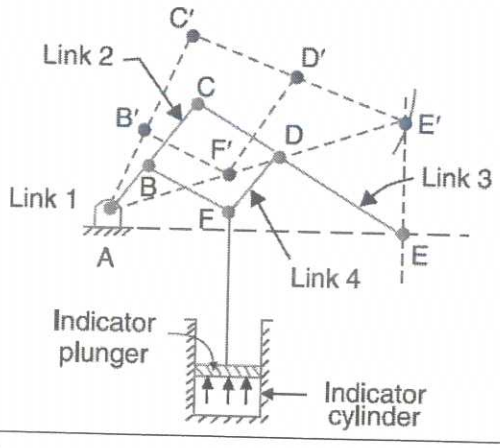
2. Coupling rod of a locomotive (Double crank mechanism).

The mechanism of a coupling rod of a locomotive (also known as double crank mechanism) which consists of four links, is shown in Fig. In this mechanism, the links AD and BC (having equal length) act as cranks and are connected to the respective wheels. The link CD acts as a coupling rod and the link AB is fixed in order to maintain a constant centre to centre distance between them. This mechanism is meant for transmitting rotary motion from one wheel to the other wheel.



3. Watt's indicator mechanism (Double lever mechanism).

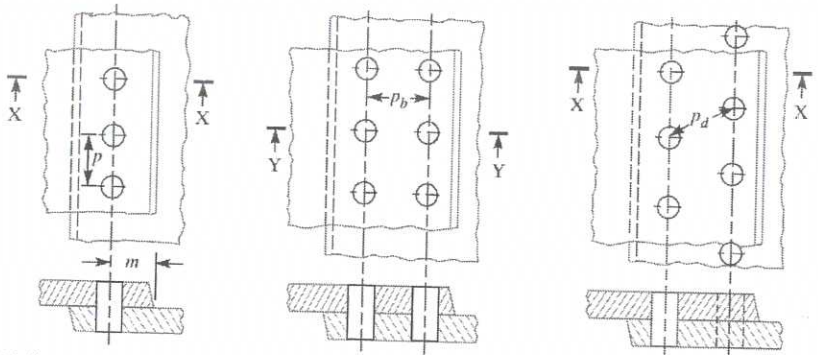
A *Watt's indicator mechanism (also known as Watt's straight line mechanism or double lever mechanism) which consists of four links, is shown in Fig. The four links are : fixed link at A, link AC, link CE and link BFD. It may be noted that BF and FD form one link because these two parts have no relative motion between them. The links CE and BFD act as levers. The displacement of the link BFD is directly proportional to the pressure of gas or steam which acts on the indicator plunger. On any small displacement of the mechanism, the tracing point E at the end of the link CE traces out approximately a straight line.



VI

1. Lap Joint:

A lap joint is that in which one plate overlaps the other and the two plates are then riveted together.



(*a*) Single riveted lap joint. (*b*) Double riveted lap joint (Chain riveting). (*c*) Double riveted lap joint (Zig-zag riveting).

Fig – 3 Marks

Expln – 4 Marks

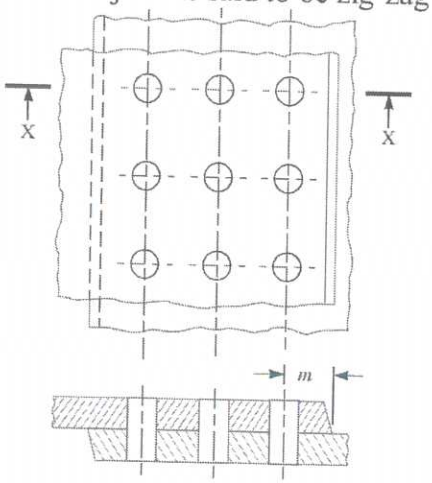
7

2. Butt Joint:

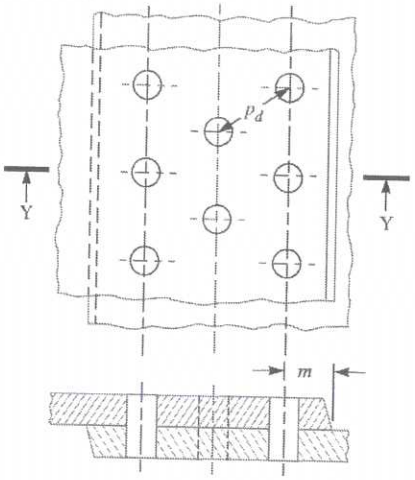
A butt joint is that in which the main plates are kept in alignment butting (i.e. touching) each other and a cover plate (i.e. strap) is placed either on one side or on both sides of the main plates. The cover plate is then riveted together with the main plates. Butt joints are of the following two types :

1. Single strap butt joint, and 2. Double strap butt joint.

In a single strap butt joint, the edges of the main plates butt against each other and only one cover plate is placed on one side of the main plates and then riveted together. In a double strap butt joint, the edges of the main plates butt against each other and two cover plates are placed on both sides of the main plates and then riveted together. When the rivets in the various rows are opposite to each other, then the joint is said to be chain riveted. On the other hand, if the rivets in the adjacent rows are staggered in such a way that every rivet is in the middle of the two rivets of the opposite row as shown in Fig, then the joint is said to be zig-zag riveted.



(*a*) Chain riveting.



(*b*) Zig-zag riveting.

Solution. Given : $P = 4$ kW $= 4000$ W ; $N = 800$ r.p.m. ; $\theta = 0.25° = 0.25 \times \frac{\pi}{180} = 0.0044$ rad ; $L = 1$ m $= 1000$ mm ; $G = 84$ GPa $= 84 \times 10^9$ N/m^2 $= 84 \times 10^3$ N/mm^2

Diameter of the spindle

Let d = Diameter of the spindle in mm.

We know that the torque transmitted by the spindle,

$$T = \frac{P \times 60}{2\pi N} = \frac{4000 \times 60}{2\pi \times 800} = 47.74 \text{ N-m} = 47\,740 \text{ N-mm}$$

We also know that $\frac{T}{J} = \frac{G \times \theta}{L}$ or $J = \frac{T \times l}{G \times \theta}$

or $$\frac{\pi}{32} \times d^4 = \frac{47\,740 \times 1000}{84 \times 10^3 \times 0.0044} = 129\,167$$

$\therefore$ $$d^4 = 129\,167 \times 32 / \pi = 1.3 \times 10^6 \text{ or } d = 33.87 \text{ say } 35 \text{ mm Ans.}$$

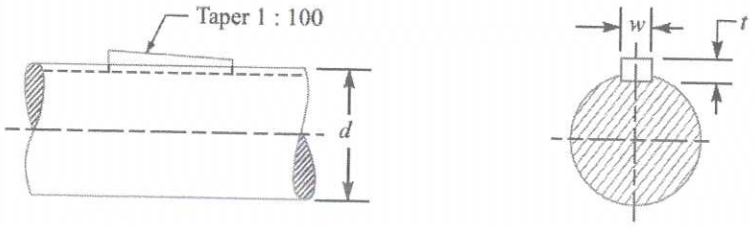
The sunk keys are provided half in the keyway of the shaft and half in the keyway of the hub or boss of the pulley. The sunk keys are of the following types :

1. *Rectangular sunk key.* A rectangular sunk key is shown in Fig. 13.1. The usual proportions of this key are :

Width of key, $w = d / 4$; and thickness of key, $t = 2w / 3 = d / 6$

where d = Diameter of the shaft or diameter of the hole in the hub.

The key has taper 1 in 100 on the top side only.



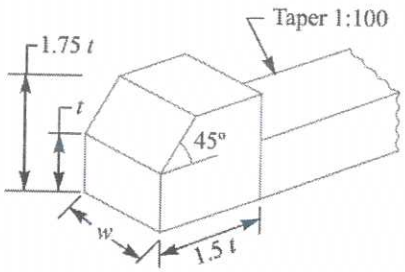
2. *Square sunk key.* The only difference between a rectangular sunk key and a square sunk key is that its width and thickness are equal, *i.e.*

$$w = t = d / 4$$

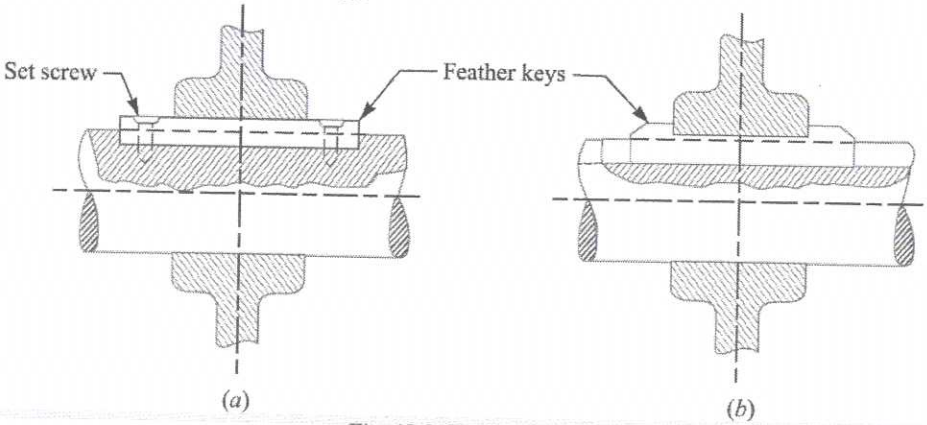
3. *Parallel sunk key.* The parallel sunk keys may be of rectangular or square section uniform in width and thickness throughout. It may be noted that a parallel key is a taperless and is used where the pulley, gear or other mating piece is required to slide along the shaft.

4. *Gib-head key.* It is a rectangular sunk key with a head at one end known as ***gib head.*** It is usually provided to facilitate the removal of key. A gib head key is shown in Fig. 13.2 (*a*) and its use in shown in Fig. 13.2 (*b*).

VIII



5. *Feather key.* A key attached to one member of a pair and which permits relative axial movement is known as ***feather key.*** It is a special type of parallel key which transmits a turning moment and also permits axial movement. It is fastened either to the shaft or hub, the key being a sliding fit in the key way of the moving piece.



6. *Woodruff key.* The woodruff key is an easily adjustable key. It is a piece from a cylindrical disc having segmental cross-section in front view as shown in Fig. 13.4. A woodruff key is capable of tilting in a recess milled out in the shaft by a cutter having the same curvature as the disc from which the key is made. This key is largely used in machine tool and automobile construction.

VII

IX

Flywheel	Governor
Flywheel reduces the fluctuation of speed during the thermodynamic cycles, but it does not maintain a constant speed.	Governor is a device to control the speed variation caused by the varying load.
The working of a flywheel does not depend upon the change in load or output required.	Governor operation depends upon the variation of load.
The operation of flywheels is continuous from cycle to cycle.	The operation of a governor is intermittent.
Speed control in a single cycle	Speed control over a period of time
The function of a flywheel is to store energy when mechanical energy is more than required for the operation and release the same when the available energy is less than required. Its inertia helps to run machines at a dead center.	The function of a governor is to regulate the fuel supply according to the load requirement and run the machine at a constant speed irrespective of the output required.
Do not have any control over the supply of charge or fuel.	Control the supply of fuel to the engine
It is relatively heavy and has large inertia force.	It's a light machine part
It is used in engines and fabricating machines such as punching machines, rolling mill, etc.	Governors are provided on engines and turbines.
It is desired where the fluctuation in input torque. e.g.: four stroke engine	Desired where the constant speed required e.g. Generator (there is even electronic governor for diesel generator)

VIII

X

1. *Rigid coupling.* It is used to connect two shafts which are perfectly aligned. Following types of rigid coupling are important from the subject point of view :

   (*a*) Sleeve or muff coupling.

   (*b*) Clamp or split-muff or compression coupling, and

   (*c*) Flange coupling.

2. *Flexible coupling.* It is used to connect two shafts having both lateral and angular misalignment. Following types of flexible coupling are important from the subject point of view :

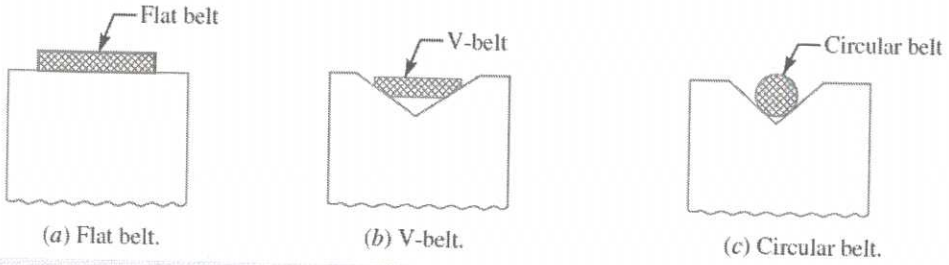
   (*a*) Bushed pin type coupling,

   (*b*) Universal coupling, and

   (*c*) Oldham coupling.

We shall now discuss the above types of couplings, in detail, in the following pages.

1. *Flat belt.* The flat belt as shown in Fig. 18.1 (*a*), is mostly used in the factories and workshops, where a moderate amount of power is to be transmitted, from one pulley to another when the two pulleys are not more than 8 metres apart.



(*a*) Flat belt. (*b*) V-belt. (*c*) Circular belt.

Fig. 18.1. Types of belts

2. *V-belt.* The V-belt as shown in Fig. 18.1 (*b*), is mostly used in the factories and workshops, where a great amount of power is to be transmitted, from one pulley to another, when the two pulleys are very near to each other.

3. *Circular belt or rope.* The circular belt or rope as shown in Fig. 18.1 (*c*) is mostly used in the factories and workshops, where a great amount of power is to be transmitted, from one pulley to another, when the two pulleys are more than 8 metres apart.

Solution. Given : $d_1 = 450$ mm = 0.45 m or $r_1 = 0.225$ m ; $d_2 = 200$ mm = 0.2 m or $r_2 = 0.1$ m ; $x = 1.95$ m ; $N_1 = 200$ r.p.m. ; $T_1 = 1$ kN = 1000 N ; $\mu = 0.25$

The arrangement of crossed belt drive is shown in Fig. 18.17.

Length of the belt

We know that length of the belt,

$$L = \pi (r_1 + r_2) + 2x + \frac{(r_1 + r_2)^2}{x}$$

$$= \pi (0.225 + 0.1) + 2 \times 1.95 + \frac{(0.225 + 0.1)^2}{1.95}$$

$$= 1.02 + 3.9 + 0.054 = 4.974 \text{ m Ans.}$$

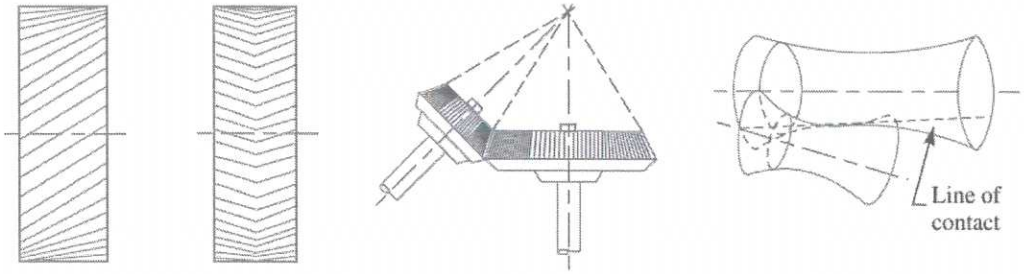
1. ***According to the position of axes of the shafts.*** The axes of the two shafts between which the motion is to be transmitted, may be

(*a*) Parallel, (*b*) Intersecting, and (*c*) Non-intersecting and non-parallel.

The two parallel and co-planar shafts connected by the gears is shown in Fig. 28.2. These gears are called ***spur gears*** and the arrangement is known as ***spur gearing.*** These gears have teeth parallel to the axis of the wheel as shown in Fig. 28.2. Another name given to the spur gearing is ***helical gearing,*** in which the teeth are inclined to the axis. The ***single*** and ***double helical gears*** connecting parallel shafts are shown in Fig. 28.3 (*a*) and (*b*) respectively. The object of the double helical gear is to balance out the end thrusts that are induced in single helical gears when transmitting load. The double helical gears are known as ***herringbone gears.*** A pair of spur gears are kinematically equivalent to a pair of cylindrical discs, keyed to a parallel shaft having line contact.

The two non-parallel or intersecting, but coplaner shafts connected by gears is shown in Fig. 28.3 (*c*). These gears are called ***bevel gears*** and the arrangement is known as ***bevel gearing.*** The ***bevel gears,*** like spur gears may also have their teeth inclined to the face of the bevel, in which case they are known as ***helical bevel gears.***

XIII



(*a*) Single helical gear. (*b*) Double helical gear. (*c*) Bevel gear. (*d*) Spiral gear.

Given:

$T_A = 30, \quad T_B = 40, \quad T_C = 60, \quad T_D = 40, \quad N_A = 36$ rpm

$N_C = ? \quad N_D = ?$

Solution:

~~XII~~

XIV

$$\frac{N_C}{N_A} = \frac{T_A}{T_B} \qquad N_C = \frac{T_A}{T_C} \times N_A \qquad = 18 \text{ rpm}$$

$$\frac{N_D}{N_A} = \frac{T_A}{T_D} \qquad N_D = \frac{T_A}{T_D} \times N_A \qquad = 27 \text{ rpm}$$