



PIE Tech

POLLACHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
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Degree/Branch: BE Mechanical Engineering

Semester/Year: III /V

Subject code & Name : ME 8594 Dynamics of Machines

Question Bank

Unit I Force Analysis

Part A (2 Marks for each questions)

1. What do you mean by inertia?

The property of matter offering resistance to any change of its state of rest or of uniform motion in a straight line is known as inertia.

2. Define inertia force?

The inertia force is an imaginary force, which when acts upon a rigid body, brings it in an equilibrium position. Inertia force = - Acceleration force = - m. a

3. State D' Alembert's principle?

D' Alembert's principle states that the inertia forces and torques, and the external forces and torques acting on a body together result in statically equilibrium.

4. State the principle of superposition?

The principle of superposition states that for linear systems the individual responses to several disturbances or driving functions can be superposed on each other to obtain the total response of the system.

5. Define:

piston effort? Piston effort is defined as the net or effective force applied on the piston, along the line of stroke. It is also known as effective driving force (or) net load on the gudgeon pin.

6. Define crank effort and crank-pin effort?

Crank effort is the net effort (force) applied at the crank pin perpendicular to the crank, which gives the required turning moment on the crankshaft. * The component of force acting along the connecting rod (FQ) perpendicular to the crank is known as crank-pin effort.

7. What do you mean by correction couple or error in torque?

The error in torque (TC) is given by $1 \propto T \cdot m \cdot l \cdot L \cdot C$ — This couple must be applied, when the masses are placed arbitrarily to make the system dynamically equivalent

8. What is meant by turning moment diagram or crank effort diagram?

It is the graphical representation of the turning moment or crank effort for various position of the crank *
In turning moment diagram, the turning moment is taken as the ordinate (Y-axis) and crank angle as abscissa (X-axis).

9. Define inertia torque?

The inertia torque is an imaginary torque, which when applied upon the rigid body, brings it in equilibrium position. It is equal to the acceleration couple in magnitude but opposite in direction.

10. Explain the term maximum fluctuation of energy in flywheel?

The different between the maximum and the minimum energies is known as maximum fluctuation of energy $\Delta E = \text{Maximum energy} - \text{Minimum energy}$

11. Define coefficient of fluctuation of energy.

It is the ratio of maximum fluctuation of energy to the work done per cycle. $\text{Coefficient of fluctuation of energy} = \frac{\Delta E}{W}$

12. What is meant by maximum fluctuation of speed?

The difference between the maximum and minimum speeds during a cycle is called maximum fluctuation of speed.

13. Define coefficient of fluctuation of speed?

The ratio of the maximum fluctuation of speed to the mean speed is called the coefficient of fluctuation of speed (CS). $\text{CS} = \frac{N_1 - N_2}{N}$ Where $N_1 = \text{Maximum speed}$, $N_2 = \text{Minimum speed}$, and $N = \text{Mean speed} = \frac{N_1 + N_2}{2}$

14. Define coefficient of steadiness?

The reciprocal of the coefficient of fluctuation of speed is known as coefficient of steadiness (m) $m = \frac{1}{\text{CS}}$

15. List out few machines in which fly wheel is used?

Fly wheel is used in: a) Punching machines, b) Shearing machines, c) Rivetting machines, and d) Crushing machines.

16. Why flywheels are needed in forging and pressing operations?

In both forging and pressing operations, flywheels are required to control the variations in speed during each cycle of an engine

17. What is cam dynamics?

Cam dynamics is the study of cam follower system with considering the dynamic forces and torques developed in it.

18. Define unbalance and spring surge?

Unbalance: A disc cam produces unbalance because its mass is not symmetrical with the axis of rotation.
Spring surge: Spring surge means vibration of the retaining spring.

19. Define windup. What is the remedy for camshaft windup?

Twisting effect produced in the camshaft during the raise of heavy load follower is called as windup * Camshaft windup can be prevented to a large extent by mounting the flywheel as close as possible to the cam.

20. What are the effect and causes of windup?

The effect of wind up will produce follower jump or float or impact. Causes of wind up are: • When heavy loads are moved by the follower, • When the follower moves at high speed, and • When the shaft is flexible.

PART B(16 Mark Questions)

1. For reciprocating engine, derive the expression for (i)Velocity and acceleration of the piston (ii)Angular velocity and angular acceleration of the connecting rod (16)

2. In a reciprocating engine mechanism, if the crank and connecting rod are 300mm and 1m long respectively and the crank rotates at a constant speed of 200r.p.m.Determine analytically, 1. The crank angle at which the maximum velocity occurs and 2. Maximum velocity of piston. 3. Derive the relevant equations. (16)

3. (i)Deduce the expression for the inertia force in the reciprocating force neglecting the weight of the connecting rod. (8) (ii)A vertical petrol engine with cylinder of 150mm diameter and 200mm strokes has a connecting rod of 350mm long. The mass is 1.6kg and the engine speed is 1800 rpm. On the expansion stroke with crank angle 30° from TDC, the gas pressure is 750KPa.Determine the net thrust on the piston.

4. (i)Define coefficient of fluctuation of speed and coefficient of fluctuation of energy. (4) (ii)The radius of gyration of a fly wheel is 1meter and fluctuation of speed is not to exceed 1% of the Mean speed of the flywheel. If the mass of the flywheel is 3340kg and the steam develops 150KW at 135rpm, then find,1.Maximum fluctuation of energy 2. Coefficient of fluctuation of energy (12)

5. The length of crank and connecting rod of a horizontal reciprocating engine are 100mm and 500mm respectively. The crank is rotating at 400rpm.When the crank has turned 30° from the IDC, find analytically 1.Velocity of piston 2. Acceleration of piston 3. Angular velocity of connecting rod 4. Angular acceleration of connecting rod.

6. The length and connecting rod of a horizontal reciprocating engine are 200mm and 1meter respectively. The crank is rotating at 400rpm.When the crank has turned 30° from the inner dead center, the difference of pressure between cover end and piston rod is 0.4 N/mm². If the mass of the reciprocating parts is 100Kg and a cylinder bore is 0.4meters.Calculate (i)Inertia force (ii) Force on piston (iii) Piston effort (iv) Thrust on the side of the cylinder walls (v) Thrust in the connecting rod (vi)Crank effort.

7. A horizontal gas engine running at 210rpm has a bore of 220mm and a stroke of 440mm. The connecting rod is 924mm long the reciprocating parts weight 20kg.When the crank has turned through an angle of 30° from IDC, the gas pressure on the cover and the crank sides are 500KN/m² and 60KN/m² respectively. Diameter of the piston rod is 40mm.Determine, 1. Turning moment on the crank shaft 2.Thrust on bearing 3. Acceleration of the flywheel which has a mass of 8kg and radius of gyration of 600mm while the power of the engine is 22KW. (16)

8. A single cylinder vertical engine has a bore of 300mm and a stroke of 400mm.The connecting rod is 1000mm long. The mass of the reciprocating parts is 140kg.On the expansion stroke with the crank at 30° from the top dead center, the gas pressure is 0.7MPa.If the runs at 250rpm, determine; 1. Net force

acting on the piston 2.resultant load on the gudgeon pin 3. Thrust on cylinder walls 4. The speed above which other things remaining same, gudgeon pin loads would be reversed in direction. (16)

9. A vertical double acting steam engine has a cylinder 300mm diameter and 450mm stroke and runs at 200rpm.The reciprocating parts has a mass of 225kg and the piston rod is 50mm diameter. The connecting rod is 1.2m long. When the crank has turned 125° from IDC the steam pressure above the piston is 30kN/m².calculate, (i)Crank-pin effort (ii)The effective turning moment on the crank shaft. (16)

10. The turning moment diagram for a petrol engine is drawn to a scale of 1mm to 6N-9-9m and the Horizontal scale of 1mm to 1° .The turning moment repeat itself after every half revolution of the engine. The area above and below the mean torque line are 305, 710, 50,350,980and 275mm². The mass of rotating parts is 40kg at a radius of gyration of 140mm.Clculate the coefficient of fluctuation of speed if the mean speed is 1500rpm. (16)

11. The torque delivered by a two stroke engine is represented by $T = (1000 + 300\sin 2\theta - 500\cos 2\theta)$ N-m where θ is the angle turned by the crank from the IDC. The engine speed is 250rpm.The mass of the flywheel is 400kg and radius of gyration 400mm. Determine , (i)the power developed (ii)the total percentage fluctuation of speed (iii)the angular acceleration of flywheel when the crank has rotated through an angle of 60° from the IDC. (iv) the maximum angular acceleration and retardation of the flywheel