Comprehensive Examination

Max. Marks: 40   **Duration: 3 Hrs.**
                                                            Date: 28-05-2008

Answer all questions.
Marks are shown in brackets against each question.
Draw suitable sketches, wherever necessary.

Question 1

A single cylinder vertical engine has a bore of 300 mm and a stroke of 400mm. The connecting rod is 1 m long. The mass of reciprocating parts is 140 kg. In the retarded position with the crank at 30^0 from TDC, the gas pressure is 0.7 MPa. If the engine runs at 250 rpm, determine

(a) the acceleration of piston using Klein's construction,

(b) net force on the piston,

(c) thrust on cylinder walls and

(d) crank pin effort   **[8M]**

Question 2

The length of crank and connecting rod of a horizontal reciprocating engine are 300 mm and 1.5 m respectively. The crank is rotating at 120 rpm clock-wise. The masses of reciprocating parts and connecting rod are 250 kg and 290 kg respectively. The centre of gravity of connecting rod is 475 mm from crank pin centre and radius of gyration about an axis passing through its centre of gravity is 625 mm. Find the actual torque on the crank shaft. $\theta = 40^0$ **[6M]**

Correction

Question 3

The turnig moment diagram of multi cylinder engine is drawn with a scale of 1 mm = 1^0 on the abscissa and 1 mm = 250 Nm on the ordinate. The intercepted areas between the torque developed by the engine and the mean resisting torque of the machine, taken in the order from one end are -350, +800, -600, +900,-550,+450 and -650 mm^2. The engine is running at a mean speed of 750 rpm and the coefficient of fluctuation of speed is limited to 0.02. Design a suitable fly wheel.   **[5M]**

Question 4

A Porter governor has equal arms each 200 mm in length and pivoted on the axis of rotation. The mass of each ball is 4 kg and that of sleeve is 20 kg. The radius of rotation of the ball is 100 mm and the governor begins to lift. If the fractional increase of speed is 1 %, determine the effort and power of governor   **[5M]**

Question 5

A ship has a propeller of mass moment of inertia 20000 kg m². The propeller rotates at a speed of 360 rpm in clock-wise sense looking from Stern. Determine gyroscopic couple under the following conditions:

(a) when it moves at 30 kmph and steers to the left at a radius of 200 m
(b) when it pitches with an amplitude of ~~100~~ $10°$ and time period is 20 sec and
(c) when it is rolling.   [5M]

Question 6

A disturbing mass 600 kg is attached to a shaft rotating at uniform angular speed of 250 rpm and its centre of gravity is at a distance of 270 mm from the axis of rotation. The disturbing mass is to be balanced by two masses which should be in different planes on either side of the disturbing plane. The distances of the centres of gravity of balancing masses from the axis of rotation is 450 mm each. The distance between the disturbing plane and one of the balancing planes is 300mm and the distance between the two balancing planes is 1.5m. Determine

(a) the distance between the plane of disturbing mass and the plane of other balancing mass and

(b) the magnitudes of balancing masses.   [5M]

Question 7

Derive the expression for variation of tractive effort for a two cylinder locomotive engine. [2M]

Question 8

A simply supported shaft of length 800 mm carries a mass of 60 kg placed 250 mm from one end and diameter of shaft is 50 mm. Find its natural frequency transverse vibration if the modulus of elasticity of the material of the shaft is 200 GPa.   [4M]

T E S T II
(OPEN BOOK)

Max. Marks: 40
Weightage: 20%

Duration: 50 Min.
Date: 20-04-2008

NOTE:

Answer all questions.
You are allowed to use prescribed text book and hand-written class notes only.
Marks are shown in brackets against each question.

Question 1

The crank shaft of a horizontal reciprocating engine is rotating clock-wise direction with a constant angular velocity of 60 rad/s. The lengths of crank and connecting rod are 100 mm and 350 mm respectively. Find the velocities and acceleration of crank shaft, connecting rod and piston when the crank has turned through 30^0 from inner dead centre. Use Klein's construction only.

[10M]

Question 2

The turning moment diagram for a multi-cylinder engine has been drawn to scale of 1 mm = 325 Nm vertically and 1 mm = 3^0 horizontally. The areas above and below the mean torque line are -26, +378, -256, +306, -302, +244, -380, +261 and -225 mm². The engine is running at a mean speed of 600 r.p.m. The total fluctuation of speed is not to exceed ±1.8% of mean speed. Design a fly wheel of suitable diameter if its mass is 107 kg. Draw the free hand sketch of turning moment diagram.

[10M]

Question 3

(a) Draw the free hand sketch of simple watt governor and justify that it is not suitable for high speeds by taking a suitable data..

[5M]

(b) A connecting rod of length 250 mm has a mass of 2.5 kg and moment of inertia 21,000 kg mm² about its centre of gravity. Centre of gravity is located at a distance of 80 mm From the crank end. If the connecting rod is replaced by two masses at the two ends, find the Correction couple that must be applied for complete dynamical equivalence of system, when Its angular acceleration is 18,000 rad/s². Draw the suitable sketch, showing the system. [5M]

Question 4

The lengths of upper and lower arms of a Porter governor are 200 mm and 250 mm respectively. Both the arms are pivoted on the axis of rotation. The central load is 150 N, the weight of each ball is 20 N and friction of the sleeve is equivalent to a force of 30 N at the sleeve. If the limiting inclination of upper arms to the vertical are 30^0 and 40^0, determine the range of speed. of governor.

[10M]

T E S T I (REGULAR)

Marks: 25
Weightage: 25%
Duration: 50 Min.
Date: 09-03-2008
- Answer all questions.
- Assume any missing data.
- Marks are shown in brackets against each question.

Question 1

(a) Explain various types of lower pairs in spatial mechanisms with suitable sketches. [5M]
(b) State D-Alembert's principle of motion and derive the expressions for linear and angular acceleration of a rigid body.

[5M]

Question 2

(a) State the conditions to achieve a dynamically equivalent system. [2M]
(b) What is meant by dynamically equivalent system? [2M]
(c) The connecting rod has a radius of gyration about it centroidal axis is 625 mm. Find the equivalent length of connecting rod if one of the masses is at a distance of 1 m from its centre of gravity. [2M]

Question 3

The length of connecting rod of a vertical double acting steam engine is 1.2 m. The diameter of the cylinder is 380 mm and the stroke of the engine is 550 mm. The crank is rotating at 200 rpm in the clock-wise direction. The crank has turned through 45^0 from TDC and piston is moving downwards. The steam pressure above and below piston is 0.5 N/mm^2 and 0.05 N/mm^2. The mass of reciprocating parts is 195 kg. The diameter of the piston rod is 50 mm. Find all the forces on the mechanism and also turning moment on the crank shaft. Neglect the friction.

Draw the sketch of the reciprocating engine mechanism, showing clearly all the forces acting on it.

[9M]