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Reg. No. :

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2025

Fifth Semester

MECHANICAL ENGINEERING

R21UME502- DYNAMICS OF MACHINERY

(Regulations R2021)

Duration: Three hours   Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. The principle used to convert dynamic system to static system   CO1-U

    (a) Newtons   (b) D'Alemberts   (c) Kinetic   (d) All the above

2. The Angular velocity of the connecting rod in a reciprocating steam engine   CO1-U
    is given

    (a) $\dfrac{\omega \sin \theta}{n}$ (b) $\dfrac{\omega \cos \theta}{n}$ (c) $\dfrac{\omega \sin \theta}{n^2}$ (d) $\dfrac{\omega \cos \theta}{n^2}$

3. If the mass of a rotating balance is 5 kg and the radius is 0.1 m, what is the   CO1-U
    centrifugal force generated at 1000 RPM?

    (a) 31.42 N   (b) 62.83 N   (c) 125.66 N   (d) 50.27 N

4. In a multi-cylinder engine, which factor determines the sequence of   CO1-U
    power strokes?

    (a) Bore diameter   (b) Firing order

    (c) Crank radius   (d) Compression ratio

5. In a vibrating system, if the actual damping coefficient is 40 N/m/s and   CO3-Ana
    critical damping coefficient is 420 N/m/s, then logarithmic decrement is equal
    to.

    (a) 0.2   (b) 0.4   (c) 0.6   (d) 0.8

6. A shaft carrying three rotors will have _____.   CO1-U

    (a) No nodes   (b) One node   (c) Two nodes   (d) Three nodes

7. To the prevention or minimization of vibrations and their transmission due to the unbalanced machines _____ .

CO1-U

    (a) Damping factor   (b) Transmissibility ratio

    (c) Vibration isolation   (d) All the Above

8. Which of the following factors does NOT affect force transmissibility in a vibrating system?

CO1-U

    (a) Frequency of forcing   (b) Damping ratio

    (c) Mass of the system   (d) Temperature of the system

9. When the sleeve of a Porter governor moves upwards, the governor speed _____ .

CO1-U

    (a) Increases   (b) Decreases

    (c) Remains unaffected   (d) All the Above

10. The gyroscopic effect in an airplane during a turn helps to _____.

CO1-U

    (a) Increase lift   (b) Maintain orientation

    (c) Decrease drag   (d) Improve fuel efficiency

PART – B (5 x 2= 10 Marks)

11. Statement of D' Alembert's principle?   CO1-U

12. Explain the significance of tractive force in locomotive dynamics.   CO1-U

13. Calculate the natural frequency of a spring-mass system with a spring constant k=2000 N/m and a mass m=10 kg, calculate the natural frequency.   CO3 Ana

14. Illustrate the magnification factor?   CO1-U

15. Classify the Governor?   CO1-U

PART – C (5 x 16= 80 Marks)

16. (a) The lengths of crank and connecting rod of a horizontal reciprocating engine 100 mm and 500 mm respectively. The crank is rotating at 400 rpm. when the crank has turned 30 from the inner dead centre, find the analytically (i) acceleration of piston (ii) velocity of piston (iii) angular velocity of the connecting rod and (iv) angular acceleration of the connecting rod   CO2- App   (16)

Or

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(b) The turning moment diagram for a multi cylinder engine has been CO2- App (16)
drawn to a scale 1 mm = 600 N-m vertically and 1 mm = 3°
horizontally. The intercepted areas between the output torque
curve and the mean resistance line, taken in order from one end,
are as follows: + 52, − 124, + 92, − 140, + 85, − 72 and + 107 m
m^2, when the engine is running at a speed of 600 r.p.m. If the total
fluctuation of speed is not to exceed ± 1.5% of the mean, find the
necessary mass of the flywheel of radius 0.5 m.

17. (a) Four masses A, B, C and D are attached to a shaft and revolve in CO4 - Ana (16)
the same plane. The masses are 12 kg, 10 kg, 18 kg and 15 kg
respectively and their radii of rotations are 4 cm, 5 cm, 6 cm and
3 cm. The angular position of the masses B, C and D are 60°,
135° and 270° from the mass A. Find the magnitude and position
of the balancing mass at a radius of 10 cm.

Or

(b) The following data apply to an outside cylinder uncoupled CO4 - Ana (16)
locomotive: Mass of rotating parts per cylinder = 360 kg; Mass of
reciprocating parts per cylinder=300 kg; Angle between cranks =
90°; Crank radius = 0.3 m; Cylinder centres = 1.75 m; Radius of
balance masses = 0.75 m; Wheel centres = 1.45 m. If whole of the
rotating and two-thirds of reciprocating parts are to be balanced in
planes of the driving wheels. Determine the Magnitude and
angular positions of balance masses.

18. (a) A shaft of length 0.75 m, supported freely at the ends, is carrying CO3 - Ana (16)
a body of mass 90   kg at   0.25   m from one end.   Find   the
natural frequency of longitudinal and transverse vibration a.
Assume E = 200 GN/m^2 and shaft diameter = 50 mm.

Or

(b) An instrument vibrates with a frequency of 1 Hz when there is no CO3 - Ana (16)
damping. When the damping is provided, the frequency of
damped vibrations was observed to be 0.9 Hz. Find 1. the
damping factor, and 2. Logarithmic decrement.

19. (a) The mass of an electric motor is 120 kg and it runs at 1500 r.p.m.   CO5- Ana   (16)
The armature mass is 35 kg and its C.G. lies 0.5 mm from the axis
of rotation. The motor is mounted on five springs of negligible
damping so that the force transmitted is one-eleventh of the
impressed force. Assume that the mass of the motor is equally
distributed among the five springs. Determine: 1. stiffness of each
spring; 2. dynamic force transmitted to the base at the operating
speed; and 3. natural frequency of the system.

Or

(b) A mass of 8 kg is suspended from a spring of stiffness 8 N/mm   CO5- Ana   (16)
and viscous damper attached to it.The damper causes the
amplitude to decrease to 10% of initial value in four complete
cycles. If a periodic force of 20 sin 50 t N is applied on the mass
in the vertical direction, find the amplitude of the forced
vibrations.

20. (a) A Porter governor has all four arms 250 mm long. The upper   CO3- App   (16)
arms are attached on the axis of rotation and the lower arms are
attached to the sleeve at a distance of 30 mm from the axis. The
mass of each ball is 5 kg and the sleeve has a mass of 50 kg. The
extreme radii of rotation are 150 mm and 200 mm. Determine the
range of speed of the governor.

Or

(b) A ship propelled by a turbine rotor which has a mass of 5 tonnes   CO3- App   (16)
and a speed of 2100 r.p.m. The rotor has a radius of gyration of
0.5 m and rotates in a clockwise direction when viewed from the
stern. Find the gyroscopic effects in the following conditions:
The ship sails at a speed of 30 km/h and steers to the left in a
curve having 60 m radius.
The ship pitches 6 degree above and 6 degree below the
horizontal position. The bow is descending with its maximum
velocity. The motion due to pitching is simple harmonic and the
periodic time is 20 seconds.
The ship rolls and at a certain instant it has an angular velocity of
0.04 rad/s clockwise when viewed from stern.
Determine also the maximum angular acceleration during
pitching. Explain how the direction of motion due to gyroscopic
effect is determined in each case.

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