Ref. No.: Ex/CE/PE/B/T/422C/2024(S)

B.E. CIVIL ENGINEERING FOURTH YEAR SECOND SEMESTER
SUPPLEMENTARY EXMINATION - 2024
SUBJECT: DYNAMICS IN GEOTECHNICAL ENGINEERING

Time: 3 HOURS Full Marks: 100
(PART I – 50 MARKS)
Use separate answerscript for each part
Assume reasonable values of data not supplied

C.O.1

1. Derive the solution of forced vibration equation for single degree of freedom system and present it graphically for both transient and steady-state condition. Also give the expression for dynamic magnification factor as a function of frequency ratio and damping ratio and show it graphically. 10

C.O.1

2. Discuss with a neat sketch the procedure of block vibration test for determination of dynamic soil parameter, coefficient of elastic uniform compression. 10

C.O.1

3. The moving component of an electric motor having a mass of 2.5 kg with an eccentricity of 160mm is running at a constant speed of 30 cps. The motor was mounted on an isolator with damping factor of 0.25. Determine the stiffness of the isolator spring such that 20% of the unbalanced force is transmitted to the foundation. Further, determine the magnitude of the transmitted force. 10

C.O.1

4. Derive the equations of motion of a block foundation subjected to vertical and rocking vibrations (Give neat sketches). Solve these equations to obtain expressions for natural frequencies and maximum amplitude. 10

C.O.1

5. A concrete block foundation of size 8.0m(L) x 4.0m(B) x 2.5m(H) is to be used as a foundation for a reciprocating engine (mounted symmetrically with respect to foundation) operating at 500rpm. The weight of the engine is 12kN. The unbalanced vertical force acting on the machine will be 2.5 sin ωt kN. The magnitude of elastic uniform compression is, Cu = 5.5 x 10^4 kN/m^3. Take unit weight of concrete = 24kN/m^3. Determine the natural frequencies and amplitude of the block by linear elastic spring-mass approach. 10

[Turn over

Ex/CE/PE/B/T/422C/2024(S)

B.E. CIVIL ENGINEERING FOURTH YEAR SECOND SEMESTER SUPPLEMENTARY EXAM 2024

DYNAMICS IN GEOTECHNICAL ENGINEERING

Part – II

Time: 3 hours | **Full Marks:** 100

[50 marks for this Part]

Use Separate Answer Scripts for Each Part

[Assume any data reasonably if necessary]

[Use code: IS 1893 (Part-I): 2016]

Sl. No.	Question	Marks
1. (a)	Discuss 'Surface Wave Magnitude Scale (M_s)' in brief.	5+5+5 [CO2]
(b)	Estimate the moment magnitude of an earthquake event with rupture length of 100km, rupture width of 45km and average fault slip of 3m. Take modulus of rigidity as $3.5\text{x}10^{10}\ N/m^2$	
(c)	Write a short note on '*Magnitude Saturation*'.	
2.	A retaining wall is 5.0 m high with a vertical back. It has a horizontal cohesionless soil (dry) as backfill. Given: Unit weight of soil = 15.2 kN/m^3 Angle of internal friction (φ) = 31° Angle of wall friction (δ) = 15° Horizontal seismic coefficient, $k_h = 0.15$ Vertical seismic coefficient, $k_v = 0.075$ (i) Determine the active force P_{AE} per unit length of the retaining wall. (ii) Determine the location of the resultant force P_{AE} with the back face of the retaining wall. **Given** $K_A = \dfrac{\cos^2(\phi-\beta)}{\cos^2\beta\cos(\delta+\beta)\left[1+\left\{\dfrac{\sin(\delta+\phi)\sin(\phi-i)}{\cos(\delta+\beta)\cos(\beta-i)}\right\}^{1/2}\right]^2}$ $K_{AE} = \dfrac{\cos^2(\phi-\theta-\beta)}{\cos\theta\cos^2\beta\cos(\delta+\beta+\theta)\left[1+\sqrt{\dfrac{\sin(\phi+\delta)\sin(\phi-\theta-i)}{\cos(\delta+\beta+\theta)\cos(i-\beta)}}\right]^2}$ where, φ = soil friction angle, β = slope of the back of the wall with vertical, $\theta = \tan^{-1}\left(\dfrac{k_h}{1-k_v}\right)$, δ = angle of friction between the wall and soil i = backfill inclination angle	[15] [CO4]

3. At a project site SPT tests have been carried out at every 0.75m depth. The measured penetration resistance with depth is given in the table (Table 1) and the soil profile obtained is also shown below. The region is expected to experience an earthquake of magnitude 7.5 with a_{max} of '0.20g' under the expected earthquake. Compute:

(i) Plot CSR and CRR variation with depth.

(ii) Estimate the free-field settlement that the site would experience using Tokimatsu and Seed (1987) Approach.

[12+8] [CO3]

Table 1

Depth (m)	0.75	1.5	2.25	3.0	3.75	4.5	5.25	6.0	6.75	7.5	8.25	9	9.75
N-value	4	6	5	5	7	9	8	12	16	20	21	25	30

0m	$\gamma_{sat} = 18\ kN/m3$	Sand
2m	$\gamma_{sat} = 19.2\ kN/m3$	Sand
5m	$\gamma_{sat} = 20.1\ kN/m3$	Silty Sand
10m		

Given:

- SPT was conducted following IS standard
- Use unit weight of water, γ_w = 10 kN/m^3 in the calculations]
- Assume Water Table at GL]

Figures Given