Master of Civil Engineering Examination, 2018
1st Yr. (2nd Semester)

Offshore Structures

Time 3 hours Full marks 100

Answer two parts in two answer scripts

Part I (60Marks)

Answer any three questions.

1. How the probability density function is developed from the time-amplitude record of a wave data? What is a cumulative distribution function? Define weak and strong stationary and ergodic processes. Correlate the autocorrelation function and spectral density function of any random process.
3+2+5+10=20

2. Correlate harmonic response function to impulse response function. Develop a transfer function relating wave elevation $\eta(t)$ to wave-generated force on the deck of a 3-legged jack-up offshore platform where the inertia regime governs. Use

$$\dot{u} = -\frac{H}{2}\omega^2 \frac{\cosh kd}{\sinh kd}\sin \omega t.$$

10+10=20

3. Explain and establish Parseval's theorem. Relate Spectral density function to variance. Correlate autocorrelation function for force, to that of structural response.
10+10=20

4. Using Rayleigh's method deduce the following relation, to find natural frequency of a 3-legged jack-up offshore rig with deck slab of mass m_d, length of legs, l, and depth of sea, d, while other variables have usual meanings:

$$\omega_n = \left[\frac{\frac{\pi^2}{8l}\left(\frac{3\pi^2 EI}{l^2}\right) - m_d g}{3\overline{m}l' + 3\overline{m}_o l'' + m_d}\right]^{1/2}, \text{ with}$$

$l' = 3d/8 - (l/2\pi)\sin(\pi d/l) + (l/16\pi)\sin(2\pi d/l)$, and

$l'' = 3(l-d)/8 + (l/2\pi)\sin(\pi d/l) - (l/16\pi)\sin(2\pi d/l)$.

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Form A: Paper –Setting Blank Ref No. –Ex/PG/CE/T/129A/2018

M.C.E. 1ST YEAR 2ND SEMESTER EXAM 2018

(~~1st~~/ 2nd Semester ~~/ Repeat / Supplementary / Annual / Bianual~~)

SUBJECT: Offshore Structures

Full Marks 40

Time: ~~Two hours~~/Three hours/~~Four hours/ Six hours~~

Use a separate Answer-Script for each part

No. of Question	PART – II	No.
1.A)	Write short note (ANY ONE) i. Endurance strength. ii. Assumptions of linear wave theory.	5
B)	Prove that water particle moves in an elliptic orbit. Show the nature of the orbit for a) shallow water condition, b) intermediate water condition and c) deep water condition For a given velocity potential $\phi = \dfrac{ag}{\omega}\dfrac{\cosh k(d+z)}{\cosh kd}\cos(kx-\omega t)$	15
2.A)	Explain the Dispersion Relation?	4
B)	A single storied fixed base jack up platform made of 20mm thick steel pipes is loaded with maximum wave height H_{max} = 3.8m with corresponding period of 7.9s. Modulus of elasticity = 2.1×10^6 kg/cm², unit weight for steel is 7.83t/m³, and that of seawater is 1.03 t/m³. Add upper quarter of the column mass with deck mass. The structure and sea level is shown below. Use Morison's equation to estimate the wave loading and find deterministic response with a time interval of 0.01s for <u>four</u> cycles using $\xi = 1.5\%$. Here F_h is given by	16

$$\pi\gamma_w D\frac{H^2L}{T^2}\left[\frac{\pi D}{4H}c_m K_2 \sin 2\pi\left(\frac{x}{l}-\frac{t}{T}\right)+c_d K_1\left|\cos 2\pi\left(\frac{x}{l}-\frac{t}{T}\right)\right|\cos 2\pi\left(\frac{x}{l}-\frac{t}{T}\right)\right]$$

$$K_1 = \frac{4\pi s_2/L - 4\pi s_1/L + \sinh(4\pi s_2/L) - \sinh(4\pi s_1/L)}{16[\sinh(2\pi d/L)]^2}, \text{ and}$$

$$K_2 = \frac{\sinh(2\pi s_2/L) - \sinh(2\pi s_1/L)}{\sinh(2\pi d/L)}, \text{ where all terms have their usual meaning.}$$