Master of Civil Engineering Examination, 2017
(2nd Semester)

Offshore Structures

Time 3 hours Full marks 100

Answer two parts in two answer scripts

Part I: (60 Marks)

Answer Q1 and any two questions from the rest.

1. What is a cumulative distribution function? Define weak and strong stationary and ergodic processes. Correlate the autocorrelation function, $R_{uu}(\tau)$ and spectral density function, $S_{uu}(\omega)$ of a random process $u(t)$.

3+5+12=20

2. Deduce expressions for Harmonic and impulse response functions and correlate them. Develop a transfer function relating wave elevation $\eta(t)$ to wave-generated force on the deck of an N-legged jack-up offshore platform where the inertia regime governs. Use

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

4+5+11=20

3. State and prove Parseval's theorem. Prove that $\int_{-\infty}^{\infty} S_{uu}(\omega)d\omega = \sigma_u^2$. Correlate autocorrelation function for force, $R_{pp}(\tau)$, to that of structural response, $R_w(\tau)$.

7+7+6=20

4. Deduce the following relation using Rayleigh's method, 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:

$$\omega_0 = \left[\frac{\frac{\pi^2}{8l}\left(\frac{3\pi^2 EI}{l^2}\right) - m_d g}{3\bar{m}l' + 3\bar{m}_o l'' + m_d}\right]^{1/2}, \text{ with}$$

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

$l'' = 3(l-d)/8 + (l/2\pi)\sin(\pi d/l) - (l/16\pi)\sin(2\pi d/l)$. 20

Form A: Paper –Setting Blank Ref No. –Ex/PG/CE/T/129A/2017

M.C.E. 1ST YEAR 2ND SEMESTER EXAM 2017

(~~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.i.	What is fatigue limit? On which factors does fatigue limit of a material depends?	5+5+10 =20
ii.	Explain the dispersion equation.	
iii.	Consider a particle initially 10m below SWL and 20m above sea bed. After the wave motion is established (Time period = 9sec , Wave height =3.5m) , what is the size and character of the orbit of the particle?	
2.	A single storied fixed base jack up platform made of 25mm thick steel pipes is loaded with maximum wave height H_{max} =4.8 m with corresponding period of 7.0s. Modulus of elasticity = 2.1X10^6 kg/cm^2, unit weight for steel is 7.83t/m^3, and that of seawater is 1.03 t/m^3. 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 four cycles using $\xi = 1.5\%$. Here F_h is given by	20

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

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

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