# BETCE EXAMINATION, 2018
## (2nd Year 1st Semester)
## Signal Theory and Noise

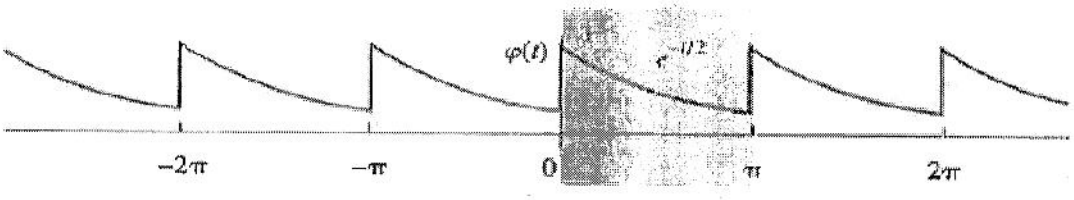
Time: Three hours | Full Marks: 100

***Write all the parts of a question in the same place***
***Answer any five questions***
***All the questions carry equal marks***

1. a) Simplify the following expression: (1)

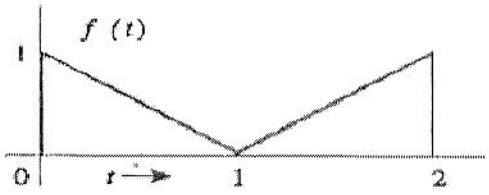
$x(t) = [\{ \sin \pi (t + 2) \} / (t^2 - 4)] \delta (t - 1)$

b) Find the r.m.s. value of the signal φ (t) as shown below: (3)

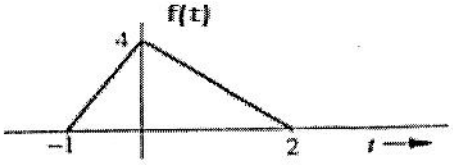



c) Find the odd and even components of the signal $g(t) = e^{-at} u(-t)$ and sketch them. (3)

d) For the given signal f(t), sketch f(2t - 3), f(3 – 2t) and f(3 - t/2) (2+2+2)



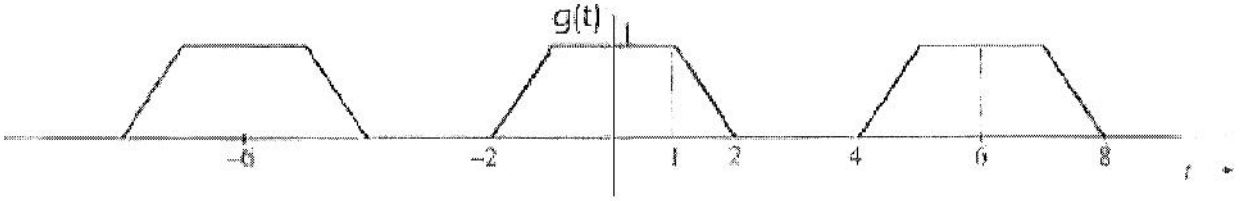

e) Express the signal f(t) by a single expression valid for all t. (4)




f) Differentiate between an energy signal and a power signal. (3)

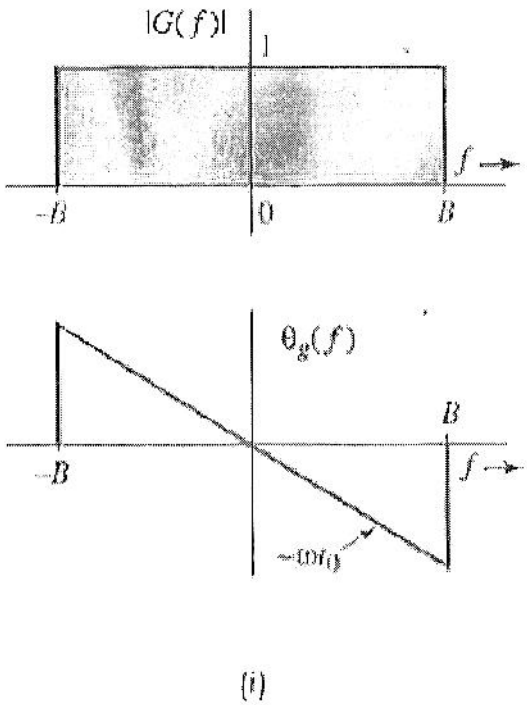
2. a) State and explain the Symmetry property of Fourier transform (3)

b) Find the exponential Fourier series and sketch the corresponding spectra for the following periodic signal: (10)

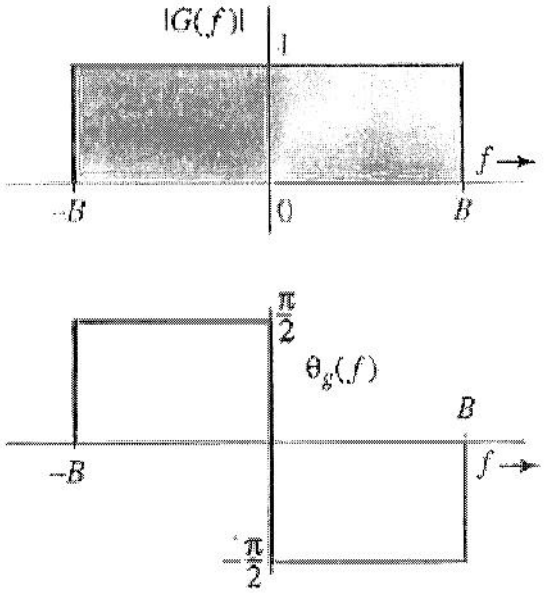



c) Establish the relation between Exponential Fourier spectra and Trigonometric Fourier spectra. (3)

d) Two different spectra are shown in parts (i) and (ii) in the figure below. Describe the signals in frequency domain. (2+2)



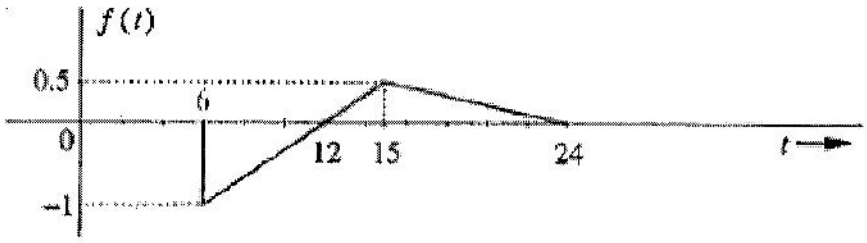

(i)



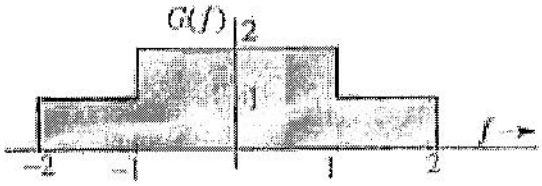

(ii)

3. a) Establish that the auto-correlation function of a signal and its Energy Spectral Density (ESD) form a Fourier transform pair. (Consider only real signal). (5)

b) Find the Fourier transform of the signal f(t) as shown below: (9)




c) Find the Inverse Fourier transform of the signal depicted below: (6)




4. a) State and prove the Sampling theorem. (2+5)

b) What do you mean by Spectral Folding? Explain with proper diagram. (4)

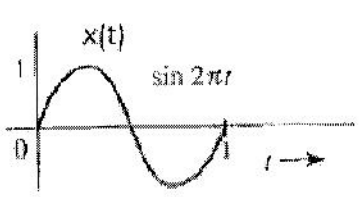
c) Considering a sinusoidal signal, draw the waveforms corresponding to Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM) and Pulse Position Modulation (PPM). (2+2+2)

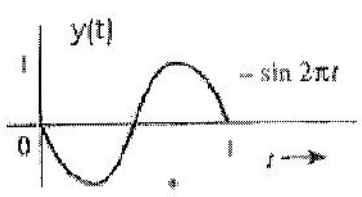
d) Determine the Nyquist rate of the signal x(t) = sin1000πt cos2000πt. Also draw the spectrum of the signal x(t) when sampled at a rate of 5000 Hz. (3)

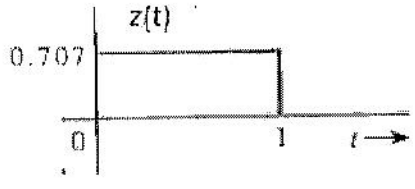
5. a) Determine the system response y(t) corresponding to an arbitrary input f(t) in terms of the unit impulse response h(t). (Use necessary diagrams). State the assumption you have made in this derivation. (8)

b) Define correlation coefficient between two signals. (2)

c) Three signals x(t), y(t) and z(t) are depicted below. Find the correlation coefficient between x(t) and y(t) & x(t) and z(t). Which pair of pulses would you select for a binary communication system and why? (1+2+2)




d) Prove Parseval's theorem. (5)

6. a) Explain, how a resistor can act as noise generator. Hence calculate the r.m.s. value of the noise voltage generated by a resistor. (2.5+2.5)

b) Explain the term Noise Figure. Hence derive the expression for the overall Noise Figure of a cascade of two stages. Also mention the assumption you have made during the calculation. (4+5+1)

c) The noise present at the input to a two-port is 1μw. The Noise Figure is 0.5dB. The receiver gain is $10^{10}$. Calculate: (2.5+2.5)
i) The available noise power contributed by the two-port.
ii) The output available noise power.

7. a) Explain that an ergodic process is stationary but a stationary process is not necessarily ergodic. (7)

b) A channel described by the term "AWGN". How will you explain the channel? (3)

c) Consider that white noise is applied to the input of an RC low-pass filter having a 3-dB frequency of $f_c$. Calculate the noise power present at the output of this filter. (5)

d) Define Noise Bandwidth of a filter. How will you calculate the Noise Bandwidth of the above filter? (3+2)

8. a) Consider that Gaussian noise is applied to the input of a filter whose transfer function is H(f). Show that the noise present at the output of this filter is also Gaussian. (5)

b) Consider that noise is confined over a narrow band around a frequency $f_0$. Derive the expressions for the quadrature components of noise. What is the significance of this type of representation? (6+4)

c) A cascade of two-stage amplifier has the following specifications: (5)

$1^{st}$ stage:
voltage gain: 25; input resistance: 1KΩ; equivalent noise resistance: 2KΩ; output resistance: 125KΩ

$2^{nd}$ stage:
voltage gain: 50; input resistance: 100KΩ; equivalent noise resistance: 20KΩ; output resistance: 2MΩ

Calculate the overall equivalent noise resistance present at the input of the cascade.