Q4. A bandlimited lowpass signal $x(t)$ of bandwidth B Hz is sampled to form

$$x_s(t) = x(t) \cdot \sum_n \delta(t - nT).$$

Let $X(f)$ and $X_s(f)$ be the spectra of $x(t)$ and $x_s(t)$, respectively.

(a) Find $X_s(f)$ in terms of $X(f)$, expressing your answer in the form of a convolution.

(3 marks)

(b) Based on the expression found in Part (a) and the information provided in the plot of $X_s(f)$ shown in Figure Q4, find B, T, and $x(t)$.

(7 marks)

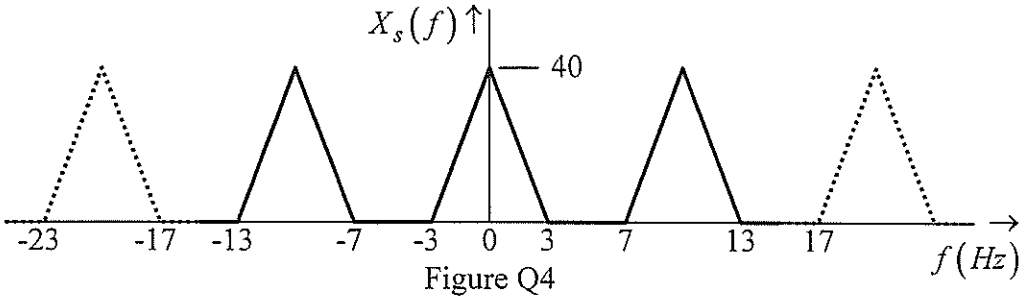

Figure Q4

Q6. The signal $x(t)$ is shown in Figure Q6.

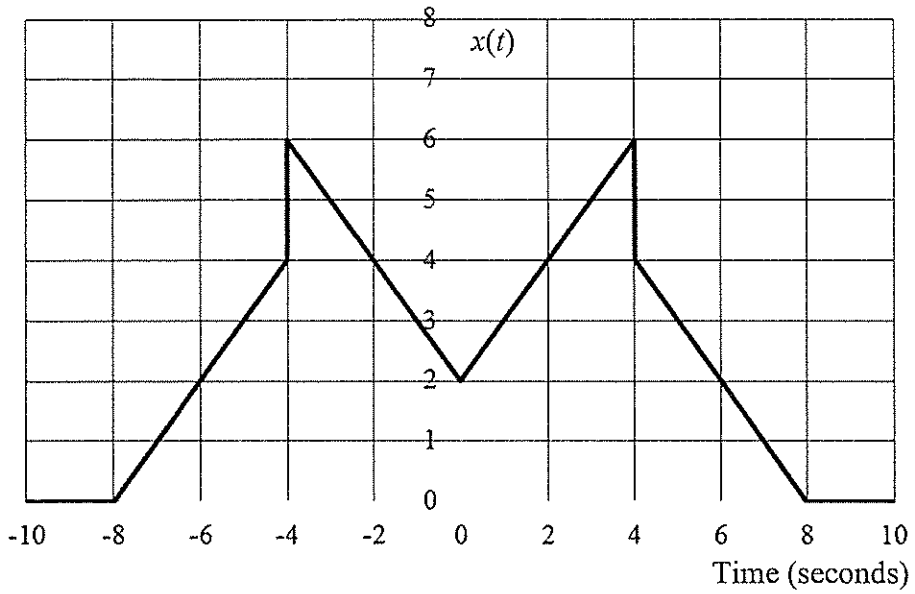

Figure Q.6 – Signal $x(t)$

(a) Determine the Fourier transform, $X(f)$, of the signal $x(t)$.

(6 marks)

(b) The signal $x(t)$ is sampled at 0.5 Hz to give the sampled signal $x_s(t)$. Obtain the Fourier transform, $X_s(f)$, of the signal $x_s(t)$.

(6 marks)

(c) The periodic signal $x_p(t)$ comprises repetitions of the pulse $x(t)$ at periodic intervals of 20 seconds.

i. Sketch the signal $x_p(t)$.

(2 marks)

ii. Determine the Fourier transform of the periodic signal $x_p(t)$.

(6 marks)

Q3. (a) Determine the Fourier transform of the signal $x(t)$ shown in Figure Q3.

(4 marks)

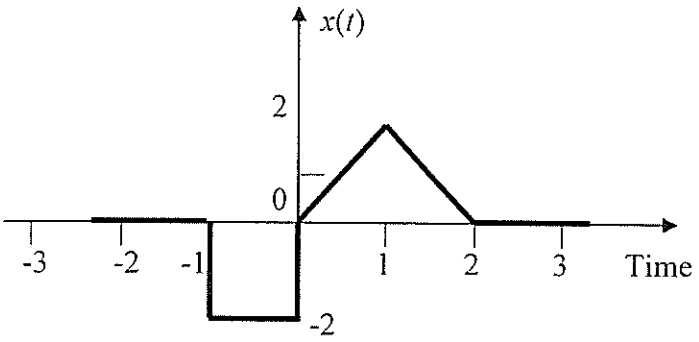

Figure Q3

(b) The periodic signal $x_p(t)$ is obtained by replicating $x(t)$ at periods of 10 seconds.

i. Determine the expression for $x_p(t)$ in terms of $x(t)$

(2 marks)

ii. Determine the Fourier transform, $X_p(f)$, of the periodic signal $x_p(t)$.

(4 marks)

Q.7 Consider the periodic signal $x(t)$ shown in Figure Q.7.

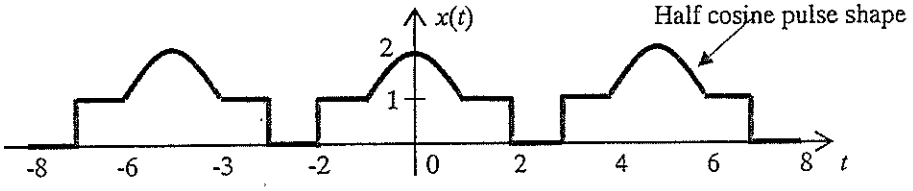

Figure Q.7

(a) Derive the Fourier transform of $x(t)$.

(6 marks)

(b) Derive the Fourier series coefficients of $x(t)$.

(3 marks)

(c) Derive an expression for the average power P of $x(t)$.

(4 marks)

(d) The 98% power containment bandwidth, W, is defined as the smallest bandwidth that contains at least 98% of the average power of the signal. Derive an expression for the 98% power containment bandwidth W.

(7 marks)