Question 1

A signal $g(t)$ band-limited to B Hz is sampled using a periodic train of pulses with a period of 1/2B and a duty cycle of 25%, with the center pulse around the origin.
Show that the sampled signal can be given by

$$g_s(t) = \frac{1}{4}g(t) + \sum_{n=1}^{\infty} \frac{2}{n\pi} \sin\left(\frac{n\pi}{4}\right) g(t) \cos\left(4n\pi Bt\right)$$

Question 2

Considering the samples of the sinusoidal signal and the modulating pulse train shown in the figure below, sketch:

- The corresponding PAM signal
- The corresponding PWM signal
- A PPM signal that does not require synchronization
- A PPM signal that reduces transmit power

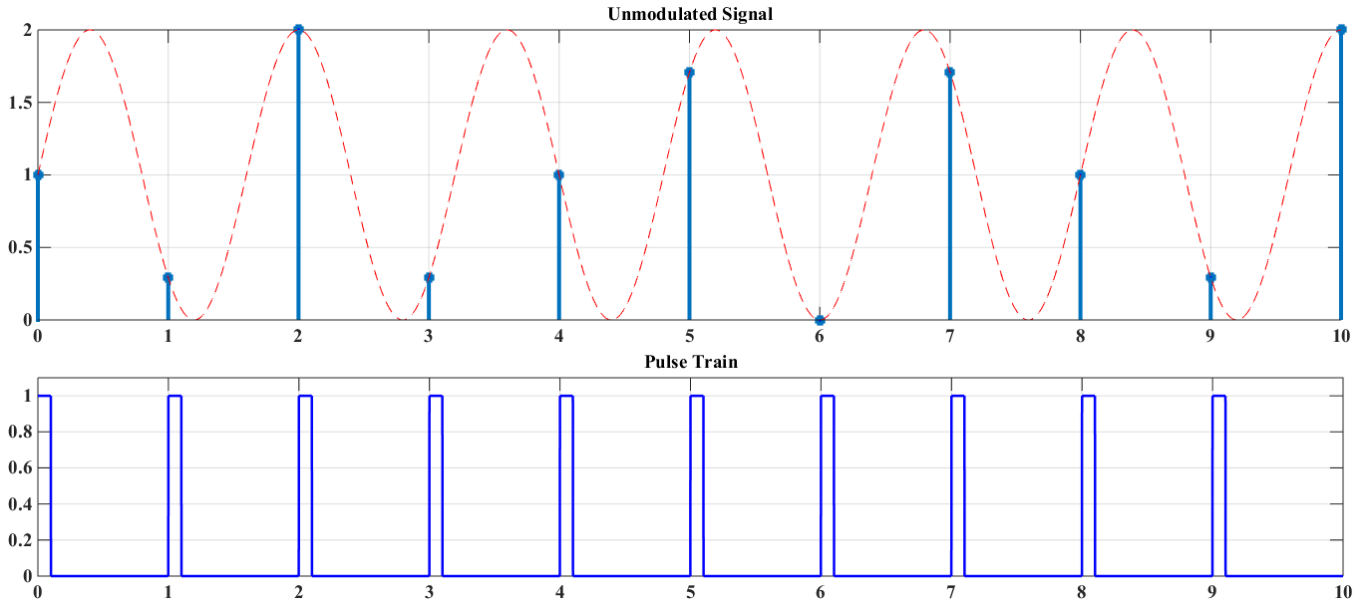

Fig. 1

Question 3

A given signal, with frequency response $M(f)$, has a maximum frequency of B Hz. The signal is instantaneously sampled with frequency f_s. Sketch the frequency response of the sampled signal, and drive conditions on f_s so that you can recover the signal properly. Also indicate how is the recovery achieved.
Repeat the problem if PAM is applied instead of instantaneous sampling.
Repeat the problem if flat-top PAM is applied instead of PAM.

Question 4

Four signals of bandwidths 0.5 KHz, 1 KHz, 2 KHz and 4 KHz. TDM is used and these signals are transmitted simultaneously by binary PCM.
Each signal must be sampled at the Nyquist rate.

1) What is the sample rate of the multiplexed signal?
2) Assuming a TDM frame, which is repeated every 1 $m$seconds:
   - How many samples of each signal should be included per frame?
   - Draw a suitable frame structure, indicating the duration of each time slot and which signal sample is transmitted per time slot.

Question 5

A TDM system is used to multiplex six signal. Two of them have bandwidths of 40 Hz, two of them have a bandwidths of 100 Hz and the last two have bandwidths of 500 Hz. The higher frequency signals are sampled at a rate of 1600 samples/second. This sampling rate is divided by 2^{R_1} and 2^{R_2} to obtain the sampling rate of the first and second pairs of lower frequency signals, respectively.

1) Find the maximum value of R_1 and R_2, given that they are integers.
2) Using these R_1 and R_2, draw the structure of the TDM frame if the six signals are multiplexed such that the first two signals are multiplexed into a new sequence, and then this sequence and the next two signals are multiplexed into a new sequence, and finally the new sequence in multiplexed with the remaining two signals.