Solution of Homework # 7
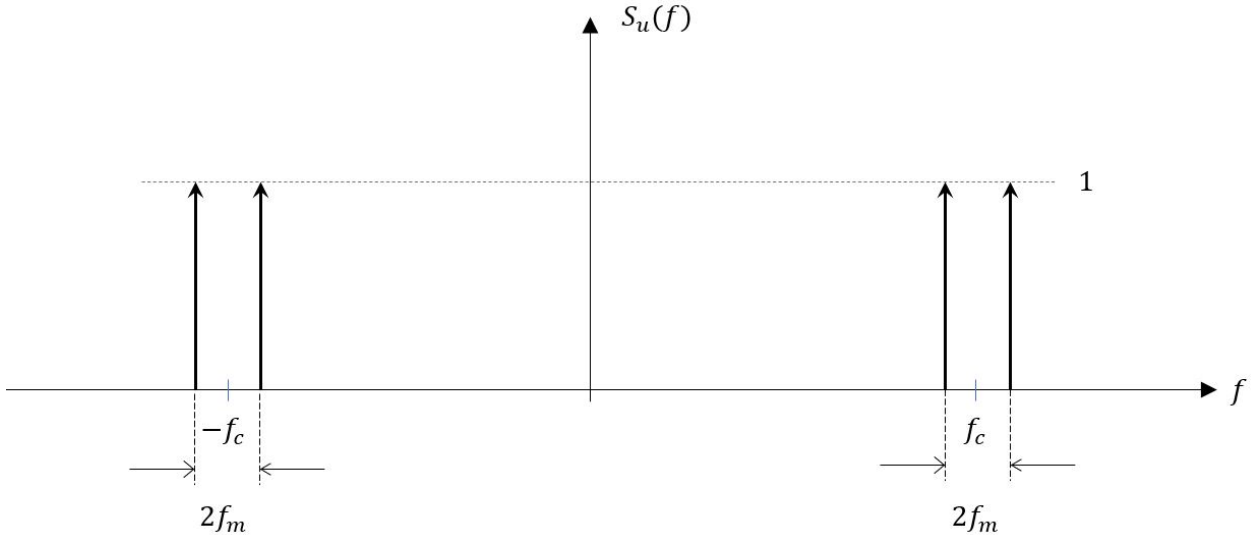
1. See solution of midterm exam 2.

2. (a) Sketch:

   (b) Average power content from the PSD:

$$P_u = \int_{-\infty}^{\infty} S_u(f)\, df = 4 \text{ W}.$$

   (c) Verification:

$$P_u = \frac{1}{T_m} \int_{-T_m/2}^{T_m/2} u^2(t)\, dt = \cdot \frac{1}{T_m} \int_{-T_m/2}^{T_m/2} \left[A_m A_c \cos(2\pi f_m t) \cos(2\pi f_c t) \right]^2 dt$$

$$= \frac{A_m^2 A_c^2}{4} \cdot \frac{1}{T_m} \int_{-T_m/2}^{T_m/2} \left[1 + \cos(4\pi f_m t) \right] \left[1 + \cos(4\pi f_c t) \right] dt = \frac{A_m^2 A_c^2}{4} = 4 \text{ W}.$$

3. (a) The noise figure is given by

$$F = F_1 + \frac{F_2 - 1}{G_1} = 10^{1/10} + \frac{10^{3/10} - 1}{10^{5/10}} = 1.5737,$$

   and it follow that NF $= 10 \log_{10}(1.5737) = 1.97$ dB.

   (b) Noise floor at the output of the IF amplifier:

$$N_{IF} = -95 \text{ dBm} + 5 \text{ dB} + 20 \text{ dB} + 1.9691 \text{ dB} = -68 \text{ dBm}.$$

   (c) IF amplifier's output SNR:

$$\left(\frac{S}{N} \right)_o (\text{dB}) = \left(\frac{S}{N} \right)_i (\text{dB}) - \text{NF} = 30 \text{ dB} - 1.97 \text{ dB} = 28 \text{ dB}.$$