1. Given an additive white Gaussian noise (AWGN) channel with SNR $= \frac{P}{\sigma^2} = \gamma$. The BER corresponding to the transmission of BPSK modulated symbols is $Q(\sqrt{\gamma})$
   Ans c
2. The Hessian of $f(\bar{\mathbf{x}}) = \frac{x_1^2}{x_2}$ is $\frac{2}{x_2^3}\begin{bmatrix} x_2 \\ -x_1 \end{bmatrix}\begin{bmatrix} x_2 & -x_1 \end{bmatrix}$
   Ans a
3. The function $\sqrt{|x|}$ is Quasi-convex
   Ans d
4. The l_∞ norm of vector $\bar{\mathbf{x}} = [x_1 \quad x_2 \quad \dots \quad x_n]^T$ is given as $\max\{|x_i|, 1 \le i \le n\}$
   Ans b
5. Given function $f(\bar{\mathbf{x}}) = \sum_{i=1}^n x_i \ln x_i$ equals the negative entropy. Since entropy is concave, negative entropy is convex. This can also be seen as follows
   $$(x_i \ln x_i)'' = (\ln x_i + 1)' = \frac{1}{x_i} \ge 0 \Longrightarrow \text{convex}$$
   Ans b
6. The function $f(x) = h(g(x))$ is convex if g is convex, and h is convex non-decreasing
   Ans a
7. Given the function $f(\bar{\mathbf{x}}) = \log \sum_{k=1}^n e^{x_k}$ and $z_k = e^{x_k}$. The Hessian of $f(\bar{\mathbf{x}})$ is
   $$\frac{\operatorname{diag}(\bar{\mathbf{z}})}{\bar{\mathbf{1}}^T\bar{\mathbf{z}}} - \frac{\bar{\mathbf{z}}\bar{\mathbf{z}}^T}{(\bar{\mathbf{1}}^T\bar{\mathbf{z}})^2}$$
   Ans d
8. The function $f(x) = h(g(x))$ is convex if g is concave, and h is convex non-increasing
   Ans c
9. Given $f(x_1, x_2) = x_1x_2$, for $x_1, x_2 > 0$,. The Hessian is $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$. Its eigenvalues are ± 1. Hence, it is not PSD and therefore, not convex. Similarly, it is not concave. It can be seen that the level sets $-x_1x_2 \le a$ or $x_1x_2 \ge a$ are convex. Hence, $-x_1x_2$ is quasi-convex, which implies x_1x_2 is quasi-concave
   Ans c
10. The function $\sum_{i=1}^m \log g_i(x)$ is concave, for $g_i(x) \ge 0$, when $g_i(x)$are concave. This can be seen as follows.
    $$(\log g_i(x))'' = \left(\frac{g_i'(x)}{g_i(x)}\right)' = \frac{g_i''(x)g_i(x) - \left(g_i'(x)\right)^2}{g_i^2(x)}$$
    It can be seen that $(\log g_i(x))'' \le 0$ if $g_i(x)$ is concave.
    Ans b