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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

MID SEMESTER EXAMINATION **SUMMER SEMESTER, 2022-2023**
DURATION: 1 HOUR 30 MINUTES **FULL MARKS: 75**

CSE 4205: Digital Logic Design

Programmable calculators are not allowed. Do not write anything on the question paper.
Answer **all 3 (three)** questions. Figures in the right margin indicate full marks of questions with corresponding COs and POs in parentheses.

1.
- $F_1(a,c,b,d) = M(5,6,9,11,12,14) \cdot D(0,1,2,4,8)$
- $F_2(a,c,b,d,e) = m(0,1,2,5,7,9,11,19,21,22,23,25,29) + d(4,10,13,17,24,30,31)$

a) Simplify the above mentioned Boolean expressions into POS format using K-map. $6+9$ (CO1) (PO1)

b) Draw the logic diagrams of the simplified expressions from Question 1.a. 5 (CO1) (PO1)

c) Find the compliments of the above-mentioned Boolean expressions. 5 (CO1) (PO1)

2. a) Analyze the logic circuit shown in Figure 1 and explain its operation. 6.5 (CO3) (PO1)

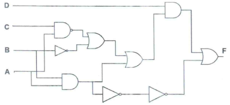

Figure 1: A logic circuit for Question 2.a

b) Can the same functionality be achieved using lesser amount of gates? Justify your answer. 6.5 (CO2) (PO2)

c) Design a combinational circuit following proper steps that takes two 4-bit BCD numbers, X and Y, as input and performs BCD addition. 12 (CO5) (PO1)

3. a) Simplify the following boolean expressions into both SOP and POS formats applying algebraic methods and draw the logic diagrams. Mention corresponding postulates and theorems for each step. 7 + 7 (CO1) (PO1)

   i. $\overline{A(\overline{CB} + BD)} + \overline{AB}$

   ii. $\overline{CC} + (DB + \overline{\overline{B}C})B$

b) With proper explanation design a combinational circuit that takes two 4-bit binary numbers, A and B, and can perform both addition and subtraction. 7 (CO5) (PO1)

c) Differentiate between: 2 + 2 (CO3) (PO1)

   i. Canonical form and Standard form of Boolean function

   ii. Minterm and Maxterm

Appendix - A

PMF/PDF, expected values and variance of known Random Variables

Families of Distribution	PMF or PDF	Expectation	Variance
Bernoulli $X \sim Ber(p)$	$P_X(x) = \begin{cases} p^x(1-p)^{1-x}, & x = 0, 1 \\ 0, & \text{otherwise.} \end{cases}$	p	$p(1-p)$
Geometric $X \sim Geom(p)$	$P_X(x) = \begin{cases} p(1-p)^{x-1}, & x = 1, 2, \ldots \\ 0, & \text{otherwise.} \end{cases}$	$\frac{1}{p}$	$\frac{(1-p)}{p^2}$
Binomial $X \sim Bin(n, p)$	$P_X(x) = \begin{cases} \binom{n}{x} p^x(1-p)^{n-x}, & x = 0, 1, \ldots, n \\ 0, & \text{otherwise.} \end{cases}$	np	$np(1-p)$
Pascal/-ve Binomial $X \sim pascal(k, p)$	$P_X(x) = \begin{cases} \binom{x-1}{k-1} p^k(1-p)^{x-k}, & x = k, k+1, \ldots \\ 0, & \text{otherwise.} \end{cases}$	$\frac{k}{p}$	$\frac{k(1-p)}{p^2}$
Poisson $X \sim Poisson(\lambda)$	$P_X(x) = \begin{cases} \frac{(\lambda T)^x e^{-(\lambda T)}}{x!}, & x \geq 0 \\ 0, & \text{otherwise.} \end{cases}$	λT	λT
Hyper Geometric $X \sim HGem(r, g, n)$	$P_X(x) = \begin{cases} \frac{\binom{r}{x}\binom{g}{n-x}}{\binom{r+g}{n}}, & x = 0, 1, \ldots, \min(r, n) \\ 0, & \text{otherwise.} \end{cases}$	$\frac{rn}{r+g}$	$\frac{nrg}{(r+g)^2}\left(1 - \frac{n-1}{r+g-1}\right)$
Uniform (discrete) $X \sim unif(a, b)$	$P_X(x) = \begin{cases} \frac{1}{b-a+1}, & x = a, a+1, \ldots, b \\ 0, & \text{otherwise.} \end{cases}$	$\frac{a+b}{2}$	$\frac{(b-a)(b-a+2)}{12}$
Exponential $X \sim exp(\lambda)$	$f_X(x) = \begin{cases} \lambda e^{-\lambda x}, & x \geq 0 \\ 0, & \text{otherwise.} \end{cases}$	$\frac{1}{\lambda}$	$\frac{1}{\lambda^2}$
Gaussian $X \sim N(\mu, \sigma^2)$	$f_X(x) = \begin{cases} \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma}}, & -\infty < x < +\infty \\ 0, & \text{otherwise.} \end{cases}$	μ	σ^2
Uniform (Continuous) $X \sim unif(a, b)$	$f_X(x) = \begin{cases} \frac{1}{b-a}, & a \leq x \leq b \\ 0, & \text{otherwise.} \end{cases}$	$\frac{a+b}{2}$	$\frac{(b-a)^2}{12}$
Gamma $X \sim gam(r, \lambda)$	$f_X(x) = \begin{cases} \frac{\lambda e^{-\lambda x}(\lambda x)^{r-1}}{\Gamma(r)}, & x \geq 0 \\ 0, & \text{otherwise.} \end{cases}$	$\frac{r}{\lambda}$	$\frac{r}{\lambda^2}$
Multinomial	$P_{X_1,\ldots,X_r}(x_1, \ldots, x_r) = \begin{cases} \binom{n}{x_1 \ldots x_r} p_1^{x_1} \ldots p_r^{x_r}, & x_i = 0, \ldots, n, 0 \leq i \leq r, \sum_{i=0}^{r} x_i = n \\ 0, & \text{otherwise.} \end{cases}$		
Multivariate Hyper geometric	$P_X(x) = \begin{cases} \frac{\binom{n_1}{x_1}\binom{n_2}{x_2}\ldots\binom{n_r}{x_r}}{\binom{n_1+\cdots+n_r}{x_1+\cdots+x_r}}, & x = 0, 1, \ldots, \min(r, n) \\ 0, & \text{otherwise.} \end{cases}$		