**Question No. 1**

You are to design a BCD to Excess-3 converter:

(a)    Draw the truth table for the converter using appropriate number of input and output variables.

(b)   Using an appropriate form of Karnaugh map, obtain simplified equations for the converter.

(c)    Use your equations from part (b) to draw the circuit for the converter.

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**Question No. 2**

You are to display the digits 0 ~ 9 using a seven segment display

(a)    Draw the truth table for the problem, illustrating which segments need to be turned on and which segments need to be turned off in order to display the digits 0~9

(b)   Using the truth table in part (a), use an appropriate number of Karnaugh maps to come up with simplified expressions for the segments.

(c)    Use your equations from part (b) to draw the circuits for the segments

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**Question No. 3**

Design a 4-bit prime-number detector. First, derive the truth table, then show the K-map and finally simplify the expression and draw the circuit.

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**Question No. 4**

CART Systems Ltd is interested in designing a circuit that would allow them to automatically turn off power lines and sound the fire alarm when a fire occurs. They also want to be able to test the fire alarms during maintenance. The board of directors approved the following specification for the design of the system …

***Input (4 variables)***

***S = 0*** indicates ***no*** smoke has been detected.

***O = 0*** indicates temperatures inside the building are ***normal***.

***M = 1***indicates ***maintenance operations*** are going on.

***P = 1***indicates there are people inside the building.

***Output (3 variables)***

***F = 1***indicates fire alarms are ***on***.

***E = 1***indicates main power lines are ***on***.

***D = 1***indicates all electronic doors are ***open***.

The directors have asked us to consider the following points when designing the system:

* If maintenance mode is on, AND we detect SMOKE, we sound the FIRE ALARM, but we keep MAIN POWER ON and we keep DOORS CLOSED.
* If we detect SMOKE ONLY, we sound the FIRE ALARM, but we keep MAIN POWER ON and we keep DOORS CLOSED.
* If we detect both SMOKE and ABNORMAL TEMPERATURES, the FIRE ALARM should be sounded, and MAIN POWER LINE should be turned OFF.
* If there are people inside the building during a FIRE EVENT (assuming MAINTENANCE is NOT going on), all electronic doors should be OPEN.
* YOU CAN ASSUME THAT ABNORMAL TEMPERATURE CANNOT BE MANUALLY GENERATED, HENCE IF ABNORMAL TEMPERATURE IS DETECTED, THERE IS DEFINITELY A FIRE EVENT ..

**a)**Using the above specification, prepare a truth table for the system.

**b)**Using 4 variable Karnaugh-Map method, derive SOP expressions for allof the three outputs.