**CEL 2 & ETL 2: Analog and Digital Systems**

**T005**

**Friday, 01/11/2013**
**8:30 - 11:30 AM**

**WORKFORCE DEVELOPMENT AUTHORITY**

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# ADVANCED LEVEL NATIONAL EXAMINATIONS, 2013, TECHNICAL AND PROFESSIONAL TRADES

## EXAM TITLE : Analog and Digital Systems

**OPTIONS:** - **Computer Electronics (CEL)**

- **Electronics and Telecommunication (ETL)**

**DURATION:** **3hours**

**INSTRUCTIONS:**

The paper contains **three (3)** sections :

**Section I**: Fourteen **(14)** questions, all **Compulsory**; **55marks**

**Section II**: Five **(5)** questions, **Choose any three (3)**; **45marks**

**Section III:** Three **(3)** questions, **choose any ONE (1)** **15marks**

## Section I: All the 14 questions are compulsory 55marks

**01.** Define the following terms : **3marks**

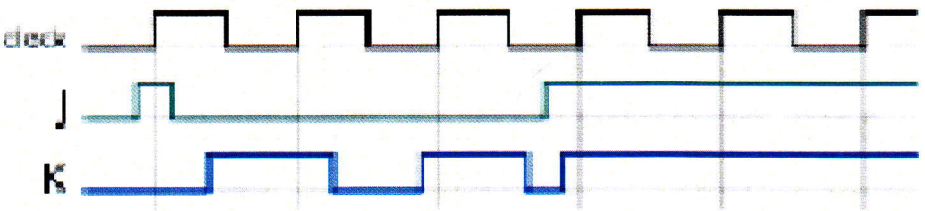
a. Code converter
b. A flip-flop
c. Modulus of a counter

**02.** Minimize the following Boolean expressions by using karnaugh map (k.map).

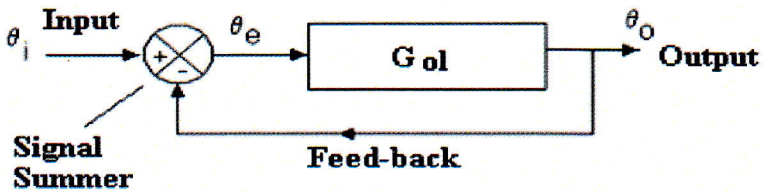
$F(W,X,Y,Z) = \Sigma\, m\,(0,1,2,4,5,6,8,9,12,13,14)$

$F = \overline{A}\,\overline{B}\,\overline{C} + \overline{B}C\overline{D} + A\overline{B}\,\overline{C} + \overline{A}BC\overline{D}$ **2marks**

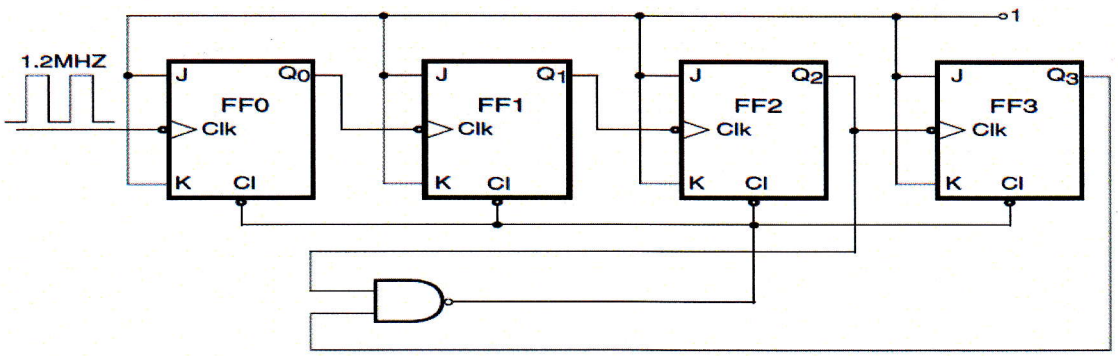
**03.** Learn the JK flip-flop waveform below and draw out the corresponding waveform of Q and $\overline{Q}$. Assume that at the initial the Q =0 (Low state). The clock signal is activated on High-to-Low transition. **2marks**




**04.** Find out the transfer function of the closed loop control system below. **3marks**




**05.** Refer to the binary ripple counter of figure shown below; determine the modulus of the counter and also the frequency of the flip-flop Q3 output. **6marks**




**06.** What are the methods for obtaining sine wave output from an inverter? **5marks**

**07.** What are the main blocks of a switched mode power supply (SMPS)? **5marks**

**08.** Identify different types of inverters or DA-AC converters. **6marks**

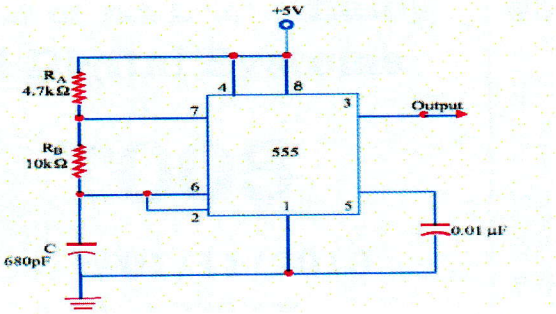
**09.** Identify two (2) among different types of protection functions that a series-pass transistor voltage regulator can include. **2marks**

**10.** Identify different types of memories based on the way data access the memory. **4marks**

**11.** Consider a family of logic gates which operates under the static discipline with the following voltage thresholds: $V_{IL}$=1.5V; $V_{OL}$=0.5V; $V_{IH}$=3.5V and $V_{OH}$=4.4V. Determine the noise margins. **6marks**

**12.** What are the two main difficulties of variable frequency system? **2marks**

**13.** Refer to this figure below,




Calculate: a) The Discharging time ($T_{OFF}$) b) The charging time($T_{ON}$)
c) The oscillation time(Period), d) The oscillation frequency
e) The duty cycle **5marks**

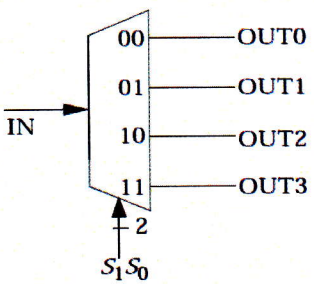
**14.** The speed of an electric motor is directly proportional to voltage such that N=20V where V is Volts and N in rev/min. The motor is controlled by a power supply which has an output voltage related to the position of the control knob by V=2φ (in degrees). Draw the block diagram and deduce the overall transfer function. Determine the output speed when the knob is set to 60°. **4marks**

## Section II. Choose and answer any three (3) questions. 30marks

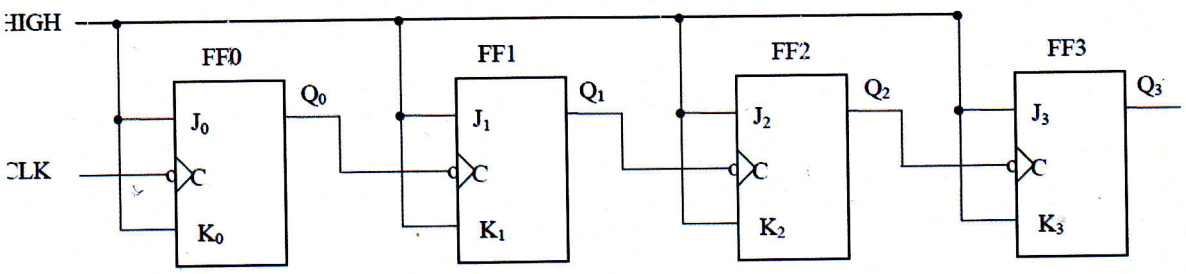
**15.** Clearly describe the working principle of 555 timers by using internal equivalent circuit **10marks**

**16.** **a)** Identify the main components of a programmable Logic Controller (PLC). **9marks**
**b)** What is a Ladder Logic? **1mark**

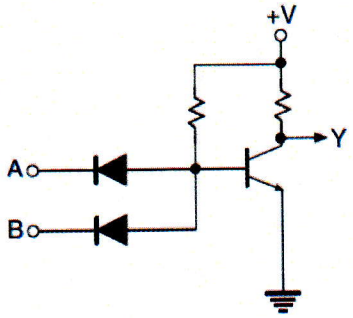
**17.** Identify the function represented by the module shown below. Determine the Boolean expression of each output and implement it using only NAND gates. **10marks**



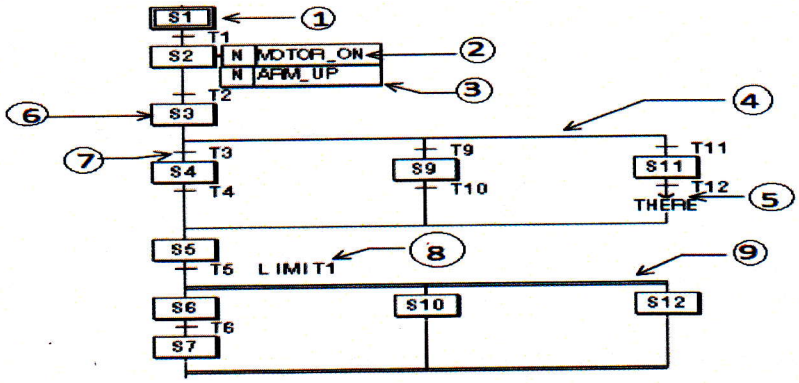

**18.** Consider the circuit shown below and answer to following questions : **10marks**
a) What type of circuit is represented?
b) If each flip-flop has a propagation delay of 10ns, determine the total propagation delay time.
c) Determine the maximum frequency (in MHz) at which the circuit is operated.
d) Develop a timing diagram showing the Q output of each flip-flop.



**19. a.** Give the function performed by the following circuit. **1mark**

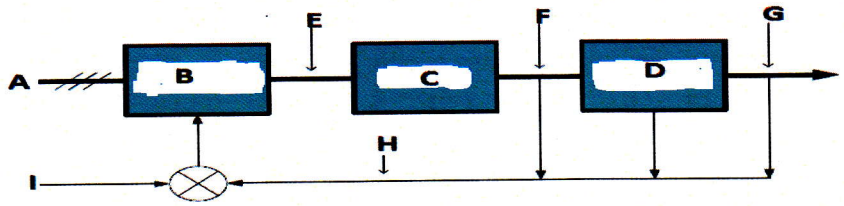



**b.** Describe each part of the following SFC. **9marks**




## Section III. Choose and answer any one (1) question 15marks

**20.** The following is a block diagram of a typical pulse width modulation adjustable speed drive configuration of a motor; determine the function or variable type represented on the diagram by letters A, B, ...., I and specify the six (6) basic protections that must be performed on such circuit. **15marks**




**21. a.** Describe the term PID in the automation control system and give its block and Transfer Characteristic. **8marks**

**b.** In the automation system describe a PI block and give the Output Characteristics of it. **7marks**

**22.** After analyzing and giving the function of the following ladder diagram, convert it into **STL and FBD.** **15marks**