Define and provide examples of *positive* and *negative* logic.

Compare & contrast and list advantages & disadvantages of *serial* and *parallel* pulse trains.

Define the terms *combinational logic* and *sequential logic*; and provide examples of each.

Define the terms *synchronous machine* and a*synchronous machine*.

Define the terms *Moore Machine* and *Mealy Machine*; and provide examples of each.

Sketch and describe the operation of a BJT transistor switch;
compare the *saturated* and the *cut-off* states to the closed and open positions of a mechanical switch.

Sketch and describe both the diode-resistor and the transistor configurations for AND and OR gates.

Describe the operation of *Astable*(Free Running), *Mono-Stable*(One Shot), and *Bi-Stable*(Flip Flop) multivibrators.

Explain the *Not Allowed* States for S-R Flip Flops

Write the Truth Table for and describe the operation of a J-K Flip Flop.

Describe practical electronic uses for each of the following: Schmitt Trigger, JK Flip Flop, NE 555 chips.

State *DeMorgan's Theorems* using Boolean algebraic symbols.

Construct true tables for AND, OR, XOR, EQV, NAND, NOR gates.

Design AND, OR, NOR, XOR, and EQV gates using only NAND gates (simple inverters are okay as needed).

Suppose P is True and Q is False (use P = 1 and Q = 0, if you wish).
Find:

$P$ AND $Q$

$P$ AND $\overline{Q}$

$\overline{P}$ OR $\overline{Q}$

$\overline{P}$ XOR $Q$

$\overline{P}$ EQV $Q$

Determine the Truth Tables for each of the diagrams (Figures A, B, C) on page 2.
Use True Tables to simplify the logic gate implementation where possible.
Draw logic gate diagrams of the solutions (use bubbles if inverters are needed, maximum of two levels deep).

Calculate the operating frequency, output time periods, and duty cycle of an 555 astable multivibrator (page 3).

## Test Three (Digital Electronics) Review and Practice Problems

See page 4 for Truth Table Solutions and Logic Gate Implementation.
See page 5 for Boolean Solutions.

Figure A.

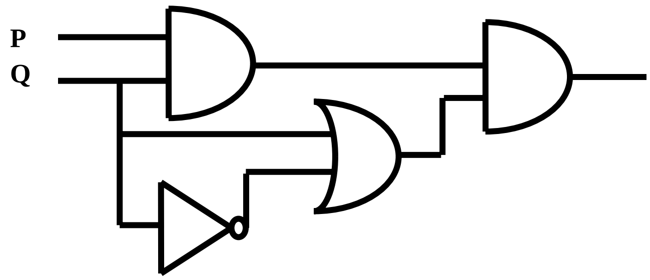



Figure B.

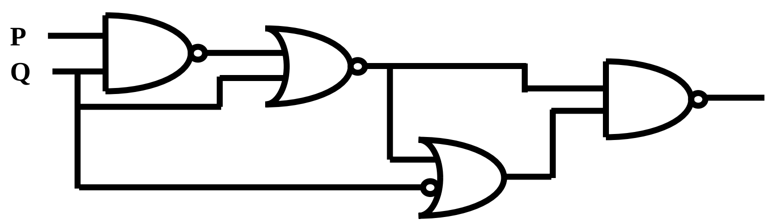
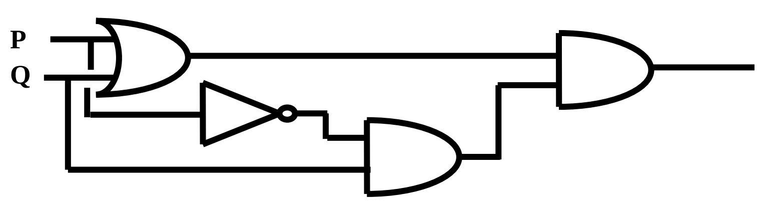


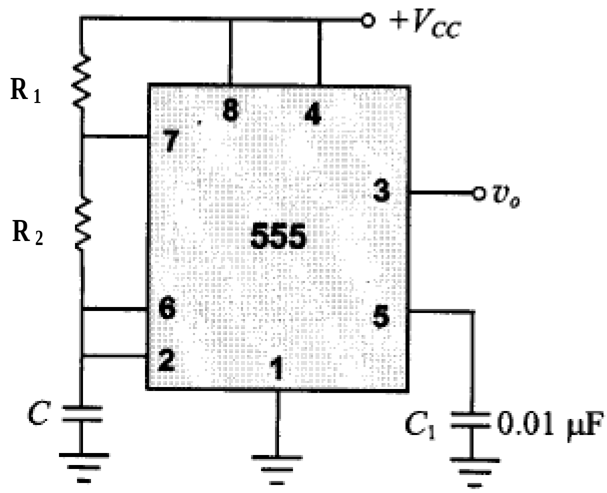

Figure C.



**Test Three (Digital Electronics) Review and Practice Problems**

Calculate the operating frequency, output time periods, and duty cycle of an 555 astable multivibrator.

Example: $R_1$ = 390 KΩ, $R_2$ = 680 KΩ, and C = 1 uf




Answers:

a. Calculate the On & Off Pulse Widths (i.e., $t_H$ & $t_L$) — $t_H$ = 0.74 sec  $t_L$ = 0.47 sec

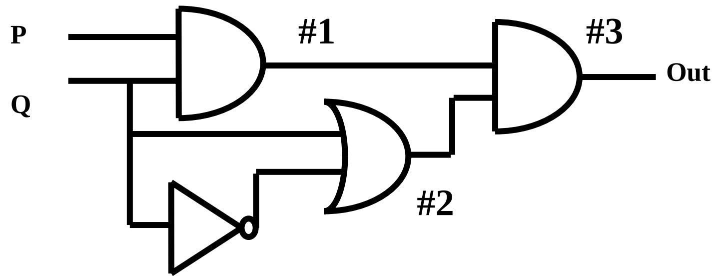
b. Calculate the Period — 1.2 sec

b. Calculate Duty Cycle — 61 %

c. Calculate the overall Operating Frequency — 0.83 Hz

## Answers (Truth Tables) to Logic Diagram Review Problems

Figure A.




| | #1 | #2 | #3 |
|---|---|---|---|
| **P Q** | **P•Q** | **$Q+\overline{Q}$** | **(#1)•(#2)** |
| 0 0 | 0 | 1 | 0 |
| 0 1 | 0 | 1 | 0 |
| 1 0 | 0 | 1 | 0 |
| 1 1 | 1 | 1 | 1 |

**Answer: P•Q**

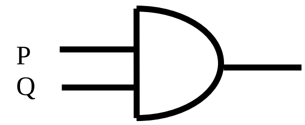
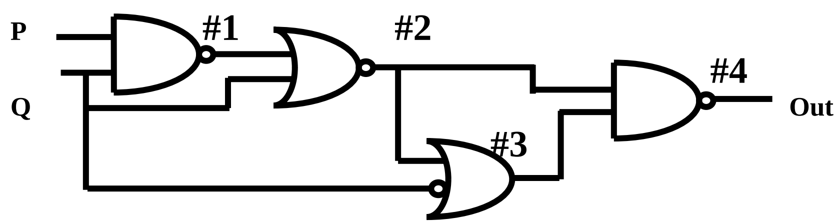



Figure B.




| | #1 | #2 | #3 | #4 |
|---|---|---|---|---|
| **P Q** | **$\overline{P\bullet Q}$** | **$\overline{\#1+Q}$** | **$\#2+\overline{Q}$** | **$\overline{(\#2)\bullet(\#3)}$** |
| 0 0 | 1 | 0 | 1 | 1 |
| 0 1 | 1 | 0 | 0 | 1 |
| 1 0 | 1 | 0 | 1 | 1 |
| 1 1 | 0 | 0 | 0 | 1 |

**Answer: 1**

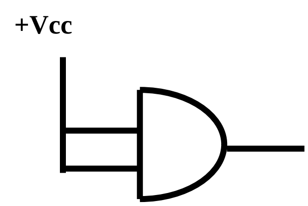
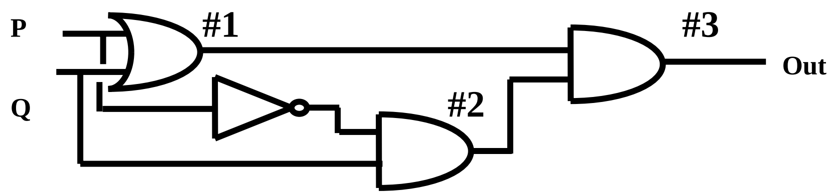
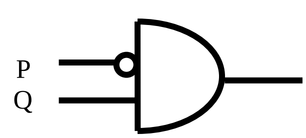



Figure C.



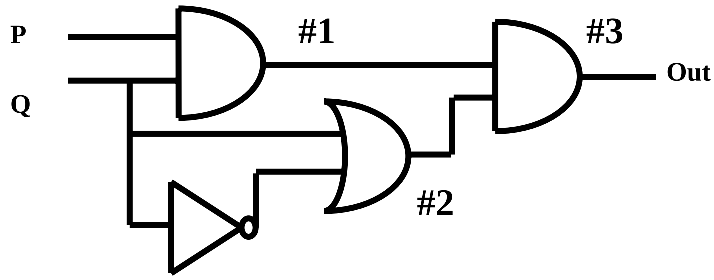

| | #1 | #2 | #3 |
|---|---|---|---|
| **P Q** | **P + Q** | **$\overline{P}\bullet Q$** | **#1•#2** |
| 0 0 | 0 | 0 | 0 |
| 0 1 | 1 | 1 | 1 |
| 1 0 | 1 | 0 | 0 |
| 1 1 | 1 | 0 | 0 |

**Answer: $\overline{P}\bullet Q$**



## Answers (Boolean Equations) to Logic Diagram Review Problems

Figure A.



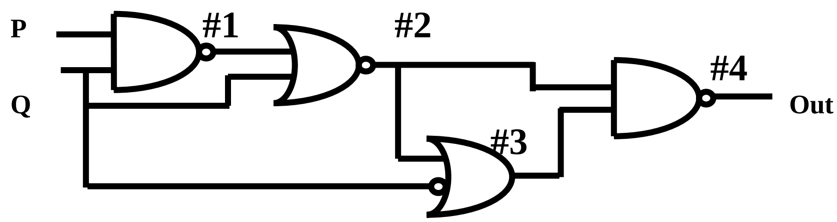

#1 $P \cdot Q$

#2 $Q + \overline{Q} = 1$

#3 $(P \cdot Q) \cdot (1) = P \cdot Q$

**Answer: P•Q**

Figure B.




#1 $\overline{P \cdot Q}$

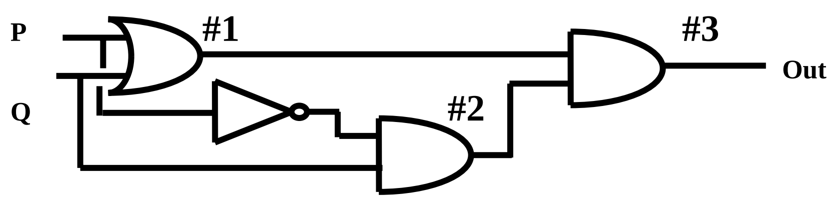
#2 $\overline{\overline{P \cdot Q} + Q} = (P \cdot Q) \cdot \overline{Q} = P \cdot Q \cdot \overline{Q} = P \cdot 0 = 0$

#3 $0 + \overline{Q} = \overline{Q}$

#4 $\overline{0 \cdot \overline{Q}} = 1 + Q = 1$

**Answer: 1**

Figure C.




#1 $P + Q$

#2 $\overline{P} \cdot Q$

*** #3 $(P + Q) \cdot (\overline{P} \cdot Q) = (\overline{P} \cdot Q) \cdot (P + Q) = (\overline{P} \cdot Q) \cdot P + (\overline{P} \cdot Q) \cdot Q = \overline{P} \cdot P \cdot Q + \overline{P} \cdot Q \cdot Q = 0 \cdot Q + \overline{P} \cdot Q = 0 + \overline{P} \cdot Q = \overline{P} \cdot Q$

*** From Boolean Algebra Properties: $A(B + C) = AB + AC$

$A(B + C) = AB + AC$ where $A = \overline{P} \cdot Q$ $B = P$ $C = Q$

$(\overline{P} \cdot Q) \cdot (P + Q) = (\overline{P} \cdot Q) \cdot P + (\overline{P} \cdot Q) \cdot Q = \overline{P} \cdot P \cdot Q + \overline{P} \cdot Q \cdot Q = 0 \cdot Q + \overline{P} \cdot Q = 0 + \overline{P} \cdot Q = \overline{P} \cdot Q$

**Answer: $\overline{P} \cdot Q$**