EE101: Basic Electronics

Theme: Micro-electronics

Tutorial Problems

Solution

General Procedure:

1. Let the series diode be D_s and the shunt diode be D_p.
2. Derive the conditions for diodes to be ON/OFF:
   - D_s is ON when V_{in} is ...
   - D_s is OFF when V_{in} is ...
   - D_p is ON when V_{in} is ...
   - D_p is OFF when V_{in} is ...

   Example: In circuits (a) and (c), D_s will be ON for $V_{in} > 0$ V. In circuits (b) and (d), D_s will be ON for $V_{in} < 0$ V
   Remember: When an ideal diode is ON, the voltage across it is equal to zero.
3. Divide V_{in} (X-axis) into segments based on the above conditions.
4. Analyze the circuit (find out V_{out}) in each segment of V_{in}. If required, draw the equivalent circuit for each segment.
5. Plot V_{out} for each V_{in} segment.

Solution for Q2:

1. Fig. 1 shows the equivalent circuits for different segments of V_{in}.
2. Transfer characteristics are given in the middle column of Fig. 3.
3. Please note that the X-axis of transfer characteristics in (b) and (e) is V_s.

Solution for Q3:

1. Fig. 2 shows the equivalent circuits for different segments of V_{in}.
2. Transfer characteristics are given in the middle column of Fig. 3.
3. Please note that the X-axis of transfer characteristics in (b) and (e) is V_s.

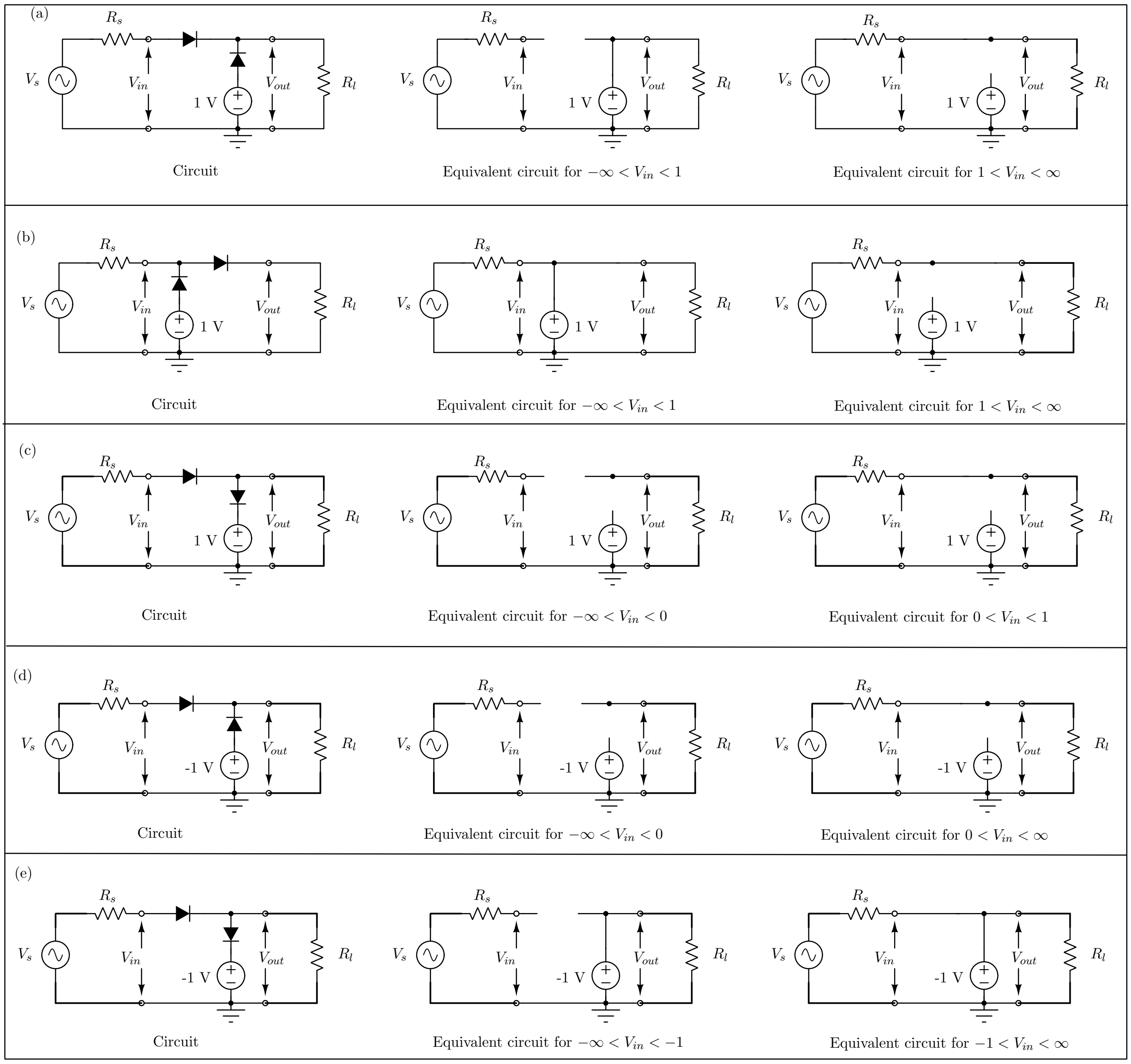

Figure 1: Equivalent circuits when the diodes are ideal

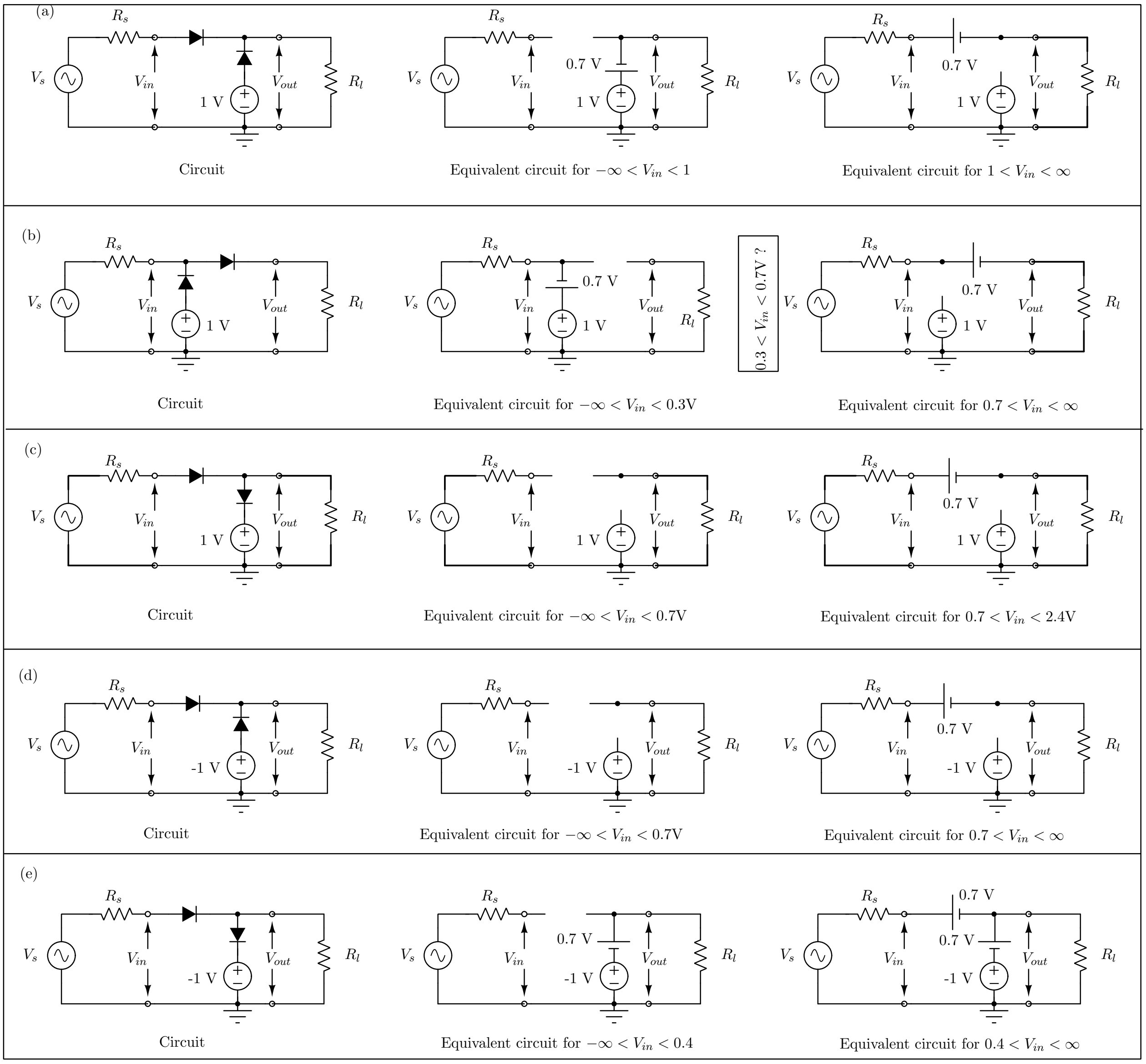

Figure 2: Equivalent circuits when the diodes have a cut-in voltage of 0.7V

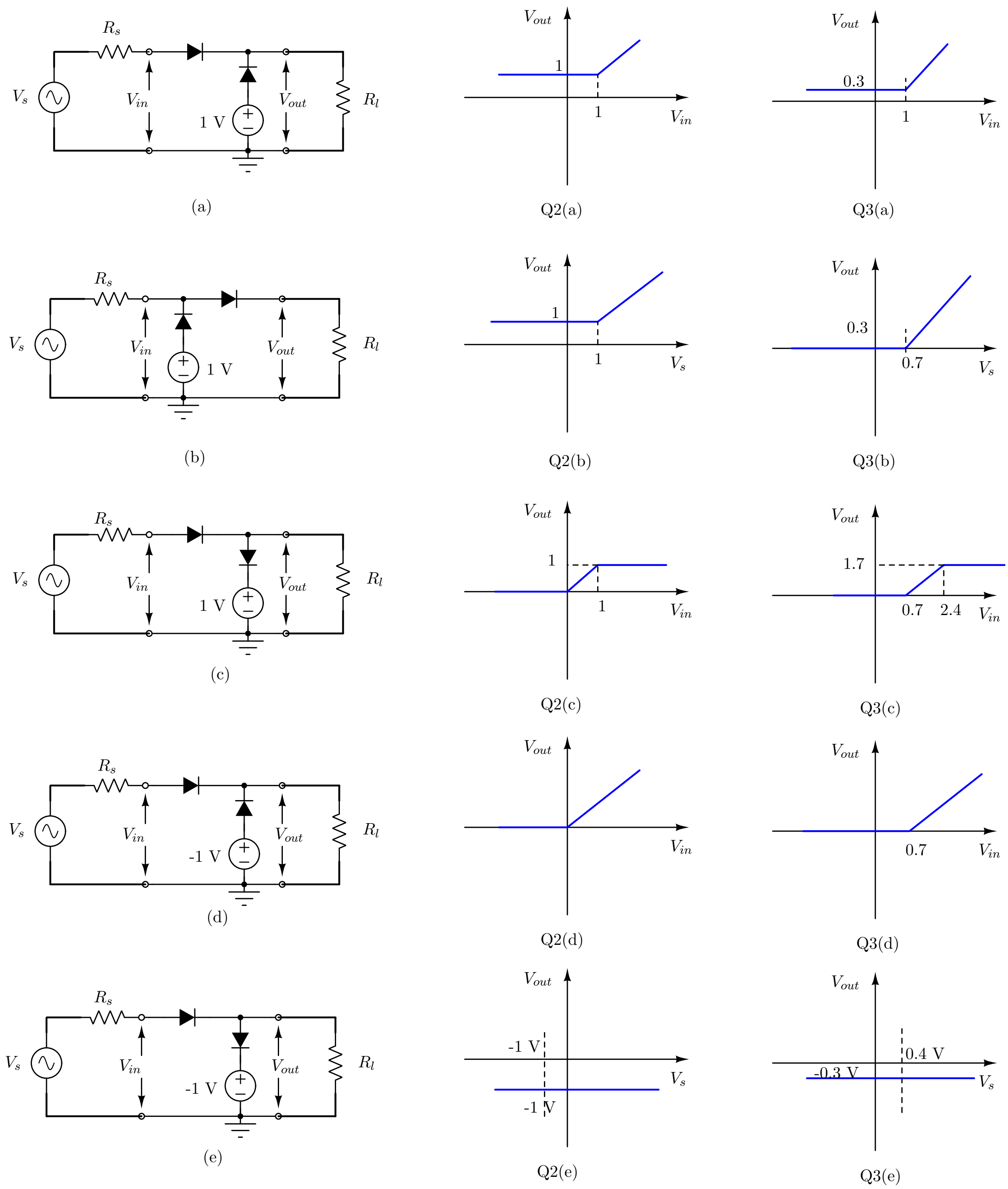

Figure 3: Transfer characteristics

Q.4

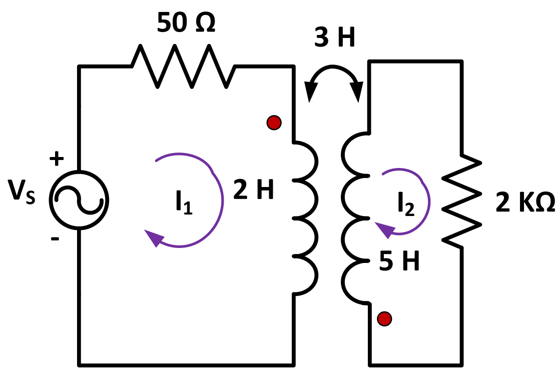

Fig. Q4

The voltage induced in the 2 H coil by the current $\boldsymbol{I_2}$ will have its positive polarity at its dotted terminal as $\boldsymbol{I_2}$ enters into its dotted terminal. The magnitude of this induced voltage will be $\boldsymbol{j\omega M I_2 = j300 I_2}$**.** Similarly, the induced voltage by $\boldsymbol{I_1}$ in 5 H coil will be $\boldsymbol{j\omega M I_1 = j300 I_1}$ and its polarity will be positive at the dotted terminal of the 5 H coil.

Applying KVL in the loop having the source and the current $\boldsymbol{I_1}$

$\boldsymbol{100 - I_1(50 + j200) - j300 I_2 = 0}$

$\boldsymbol{\Longrightarrow I_1(5 + j20) + j30 I_2 = 10}$ -------------------- (1)

Applying KVL in the second loop, i.e. loop with current $\boldsymbol{I_2}$

$\boldsymbol{-j\omega 5 I_2 - 2000 I_2 - j\omega 3 I_1 = 0}$

$\boldsymbol{\Longrightarrow j3 I_1 + I_2(20 + j5) = 0}$ -------------------------(2)

Solving equation (1) & (2)

$\boldsymbol{I_2 = 0.069\angle - 168.04^0}$ **A**, $\boldsymbol{I_1 = 0.475\angle - 64.04^0}$ **A**

a) Power absorbed the source = $\boldsymbol{V_S\, I_1 \cos\theta = -100 \times 0.475 \cos(64.04^0)}$ (-ve sign is used as the current enters the –ve polarity of the voltage source)

$= \boldsymbol{-20.80\ watt}$ (-ve sign indicate power is being delivered)

b) **P**$_{50}$ = $\boldsymbol{I_1^2 \times 50 = 11.28}$ W , **P**$_{2K}$ = $\boldsymbol{I_2^2 \times 2K = 9.52}$ W

c) & d) No power will be absorbed by the inductances and the mutual inductance.

Q.5

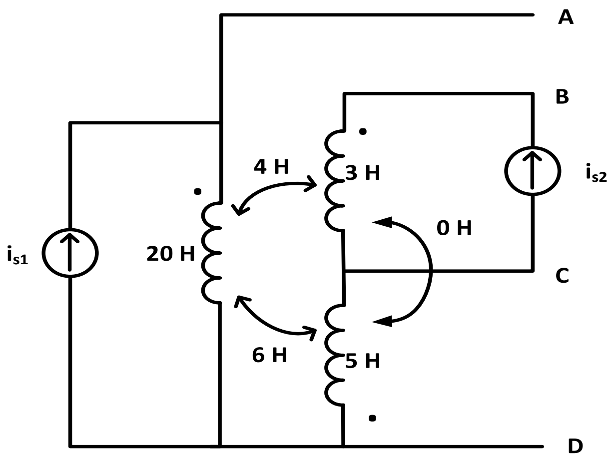

Fig. Q5

When current enters into a dotted terminal, it will induce a voltage in the other coil where the positive polarity of the induced voltage will be the corresponding dotted terminal.

$$V_{AD} = 20\frac{di_{s1}(t)}{dt} + 4\frac{di_{s2}(t)}{dt}$$
$$= 20 \times 4 + 4 \times 10 = 120\ V$$
$$V_{CD} = -6\frac{di_{s1}(t)}{dt} = -6 \times 4 = -24V$$
$$V_{BD} = V_{BC} + V_{CD} = 3\frac{di_{s2}(t)}{dt} + 4\frac{di_{s1}(t)}{dt} - 6\frac{di_{s1}(t)}{dt}$$
$$= 3 \times 10 + 4 \times 4 - 6 \times 4 = 22V$$