

Note: All questions are compulsory.

1. a) For Fig 1, prove the following equation

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$$i = k_n \frac{W}{L} \left[ -V_t v - \frac{1}{2} v^2 \right], \text{ for } v < -V_t; i = \frac{k_n}{2} \frac{W}{L} V_t^2, \text{ for } v \geq -V_t$$

- b) Threshold voltage of a MOSFET is -1.6 V. Which all MOSFET's satisfy this specification? Draw symbol, drain characteristics and transfer characteristics of these MOSFET's.

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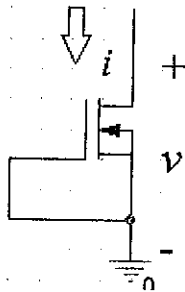


Fig 1

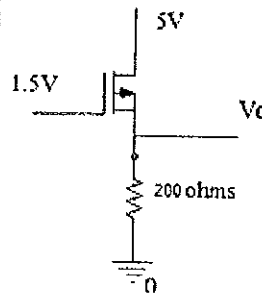


Fig 2

2. a) Explain the working of a MOS with  $n$ -type substrate with the help of energy band diagram.
- b) Show junction depletion region width, junction depth, oxide thickness, and length of channel on MOS device structure. Give the related formulas also.
3. a) Calculate  $I_D$  and  $V_{DS}$  for  $V_{tp} = -1.0$  V,  $K_p = 100 \mu A/V^2$ , and  $W/L = 4$  for the circuit shown in fig 2.
- b) Calculate the drain current for  $V_{DS} = 3$  V,  $V_{GS} = 3$  V and  $V_{SB} = 3$  V. Given that  $V_{ton} = 0.55$  V,  $W/L = 10$ , gate oxide with a thickness =  $120 \text{ \AA}$ , the p type bulk region is doping =  $8 \times 10^{14} \text{ cm}^{-3}$  and  $\mu_n = 540 \text{ cm}^2/\text{V-sec}$ .

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