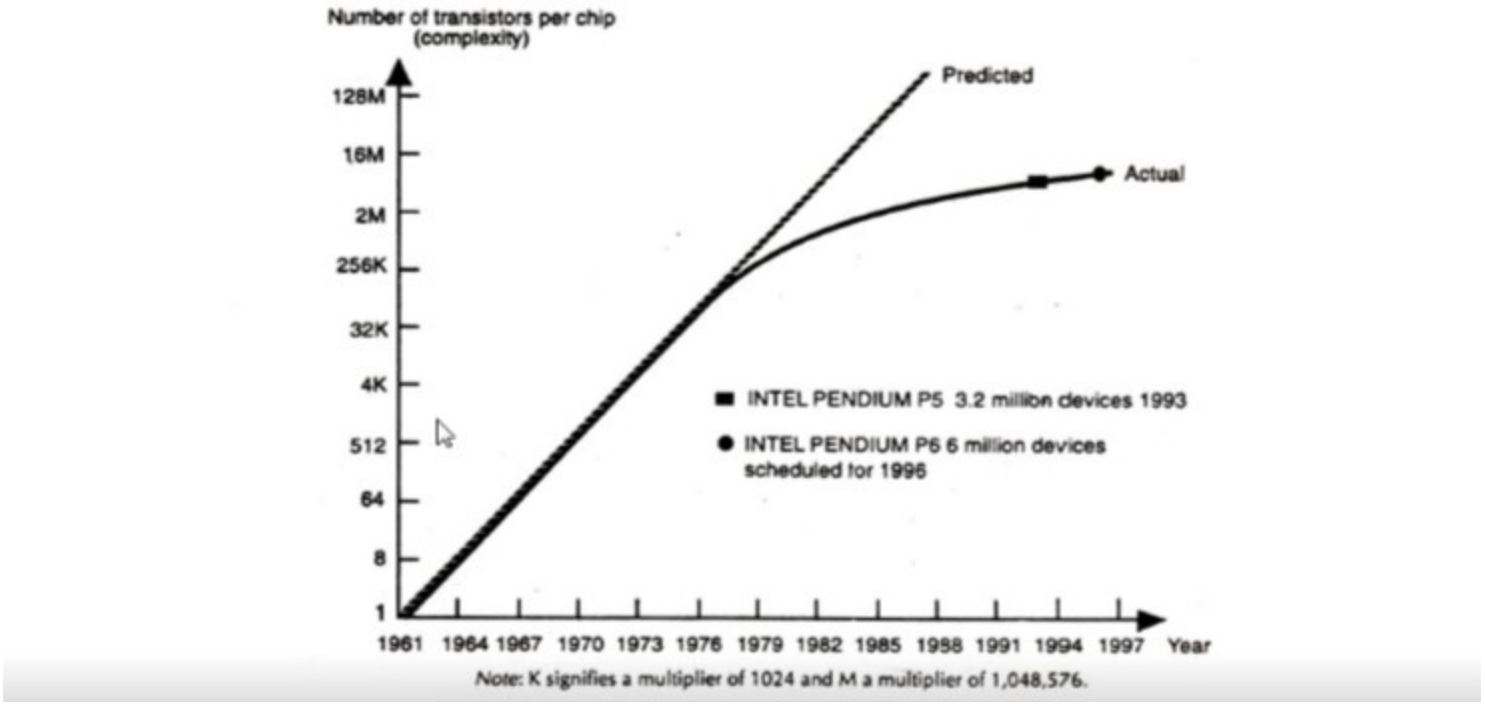
INTRODUCTION TO INTEGRATED CIRCUIT TECHNOLOGY



Note: K signifies a multiplier of 1024 and M a multiplier of 1,048,576.

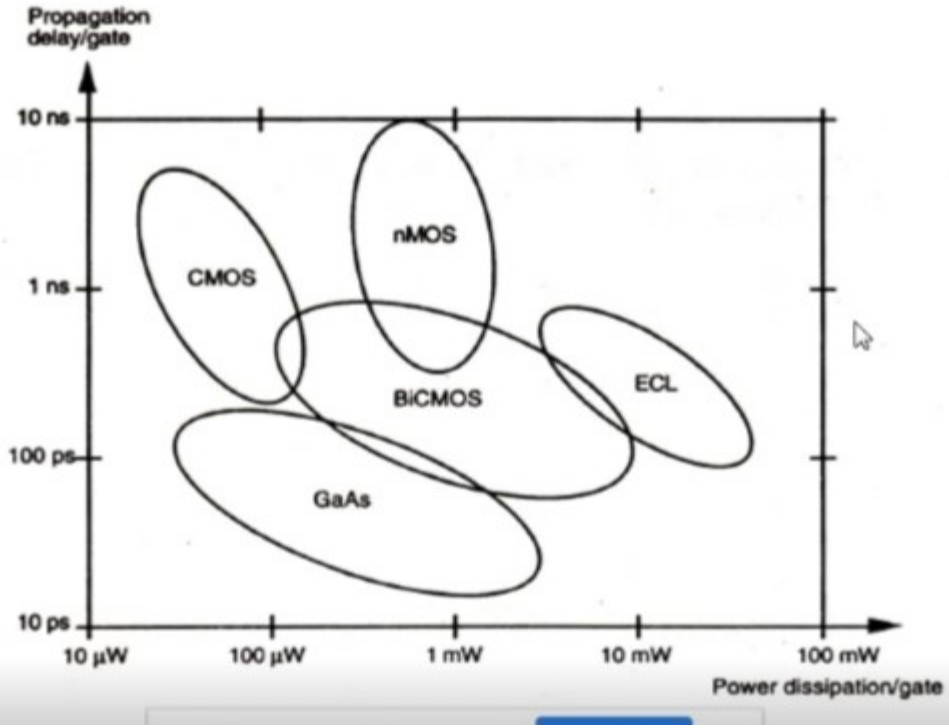
METAL-OXIDE-SEMICONDUCTOR (MOS) AND RELATED VLSI TECHNOLOGY

TABLE 1.1 Microelectronics evolution

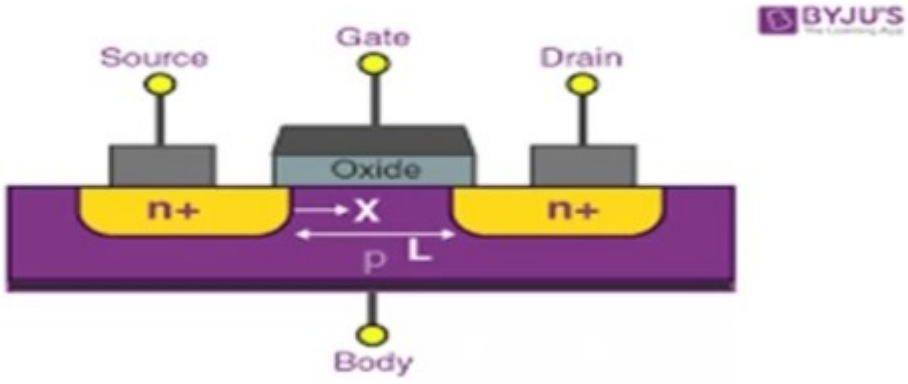
Year	*1947*	*1950*	*1961*	*1966*	*1971*	*1980*	*1990*	*2000*
Technology	*Invention of the transistor*	*Discrete components*	*SSI*	*MSI*	*LSI*	*VLSI*	*ULSI**	*GSI†*
Approximate numbers of transistors per chip in commercial products	1	1	10	100–1000	1000–20,000	20,000–1,000,000	1,000,000 10,000,000	>10,000,000
Typical products	—	Junction Transistor and diode	Planar devices Logic gates Flip-flops	Counters Multiplexers Adders	8 bit micro-processors ROM RAM	16 and 32 bit micro-processors Sophisticated peripherals GHM Dram	Special processors, Virtual reality machines, smart sensors	

* Ultra large-scale integration
† Giant-scale integration

DIFFERENT FABRICATION TECHNOLOGIES

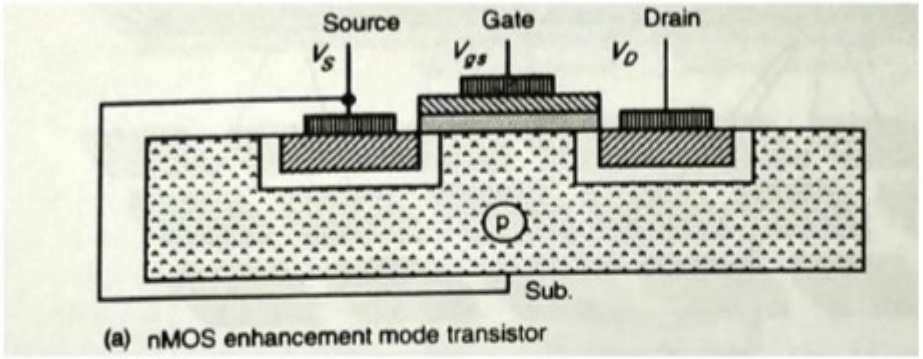


MOSFET

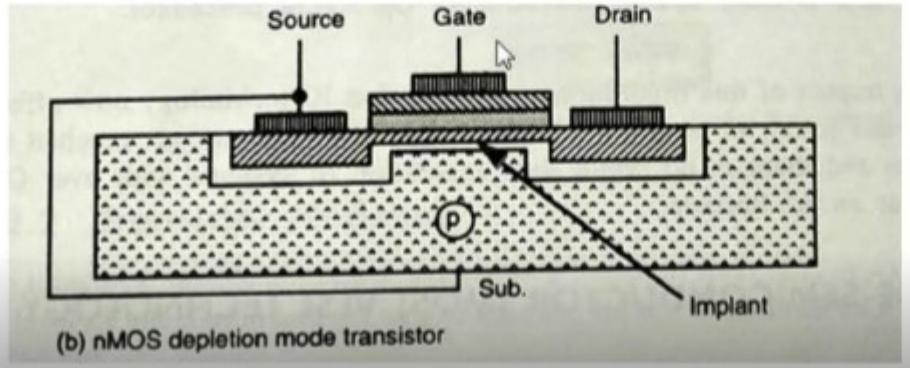


Fundamentals of MOSFET

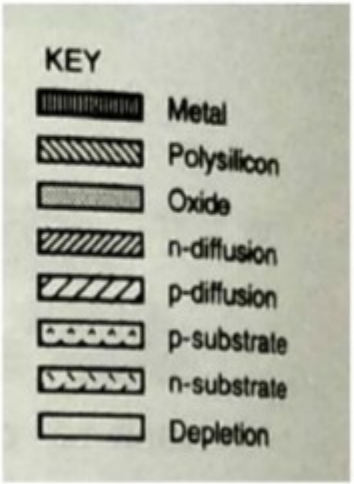
Basic MOS Transistor



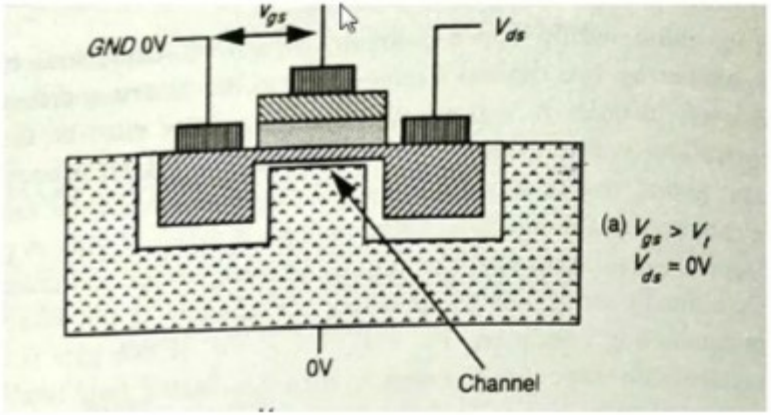
(a) nMOS enhancement mode transistor

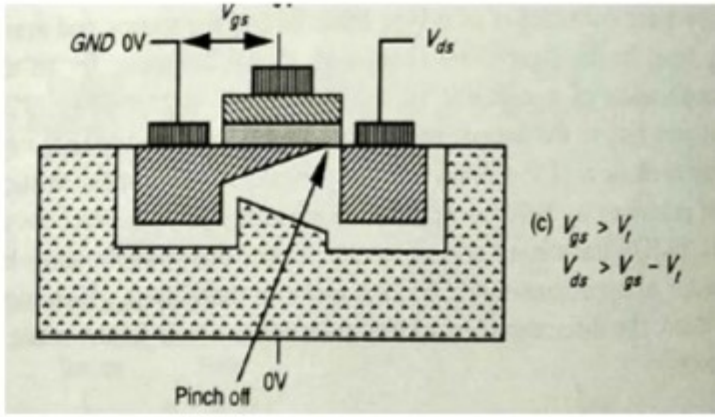


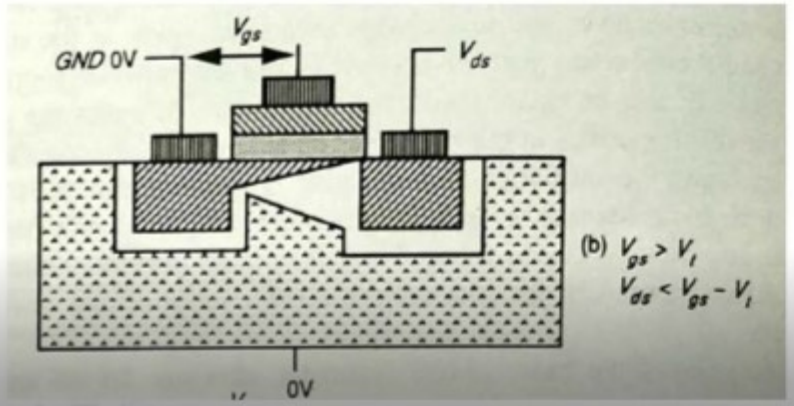
(b) nMOS depletion mode transistor



Enhancement mode Transistor



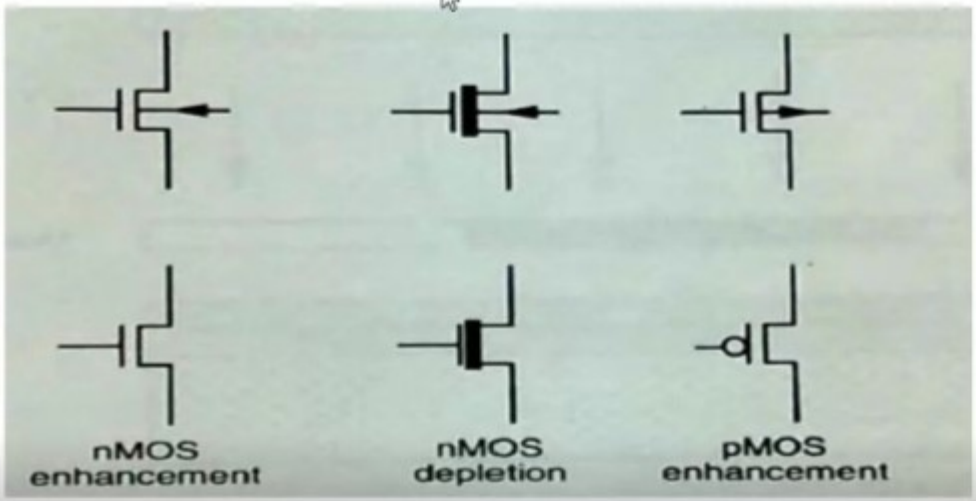




Enhancement mode transistor for particular values Vds with (Vgs>Vt)

Depletion Mode Transistor

- The channel is established because of the implant even when Vgs=0 and
- To cause the channel to cease to exist a negative voltage Vtd must be applied between gate and source
- $V_{td}<-0.8V_{DD}$



Transistor Circuit Symbols