

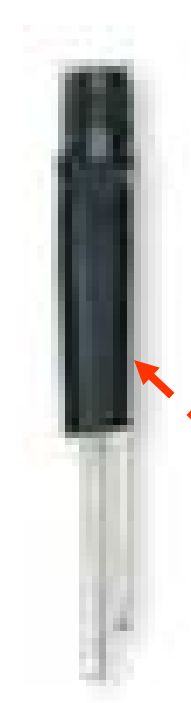
Lecture 12

Infrared Sensors

InfraRed

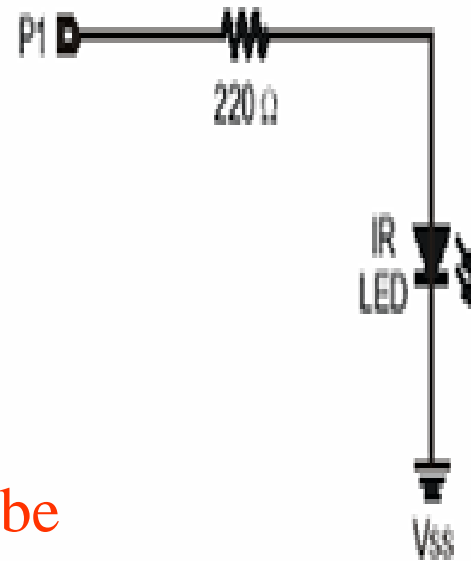
- Light that has lower frequency than red light
- Application
 - Night-vision goggles
 - IR temperature sensor
 - Object detection
 - Distance determination

IR Transmitter

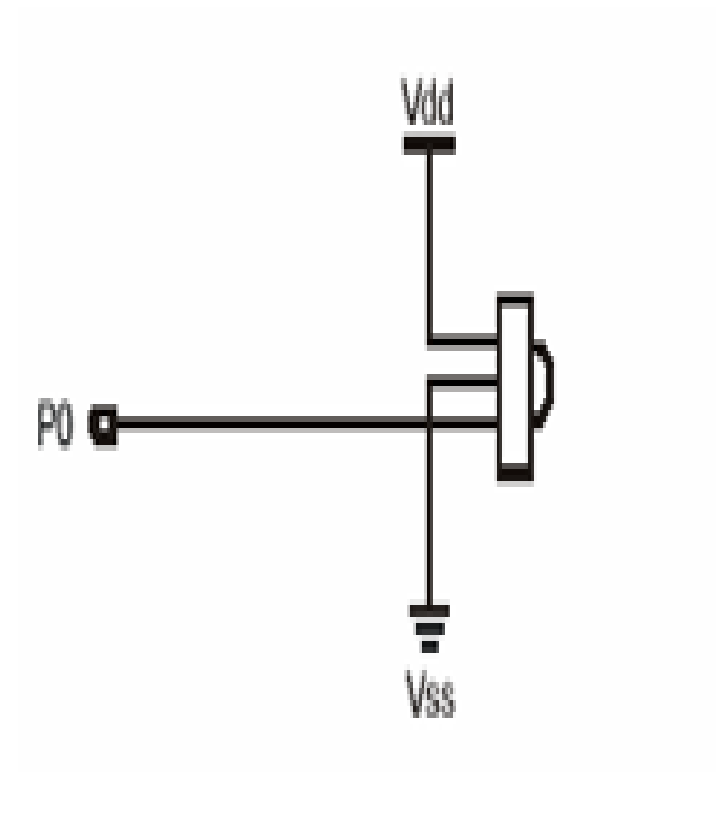
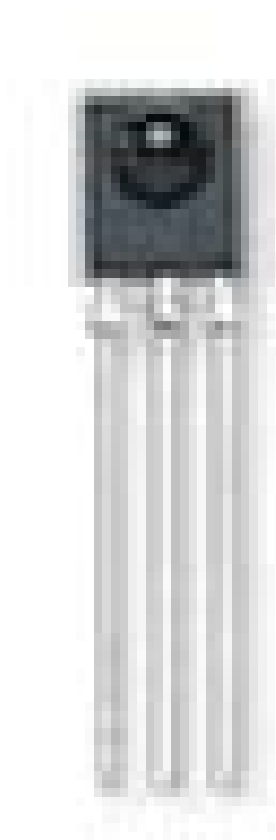


IR LED

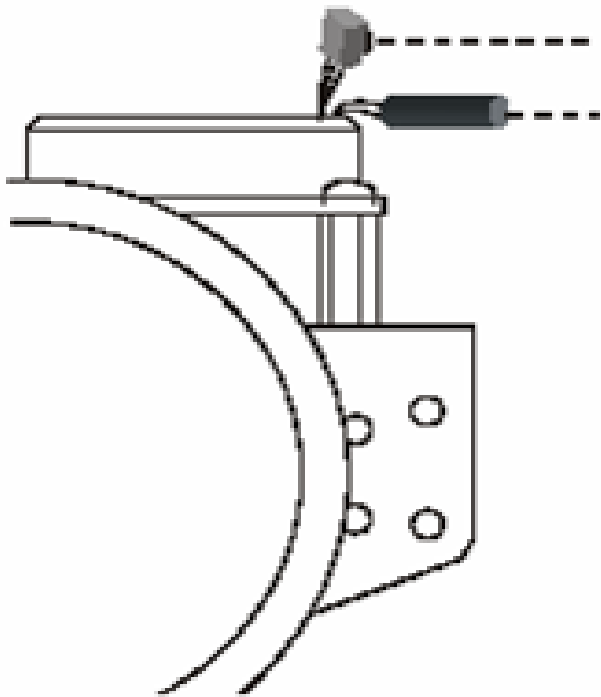
Heat Shrink Tube



IR Detector

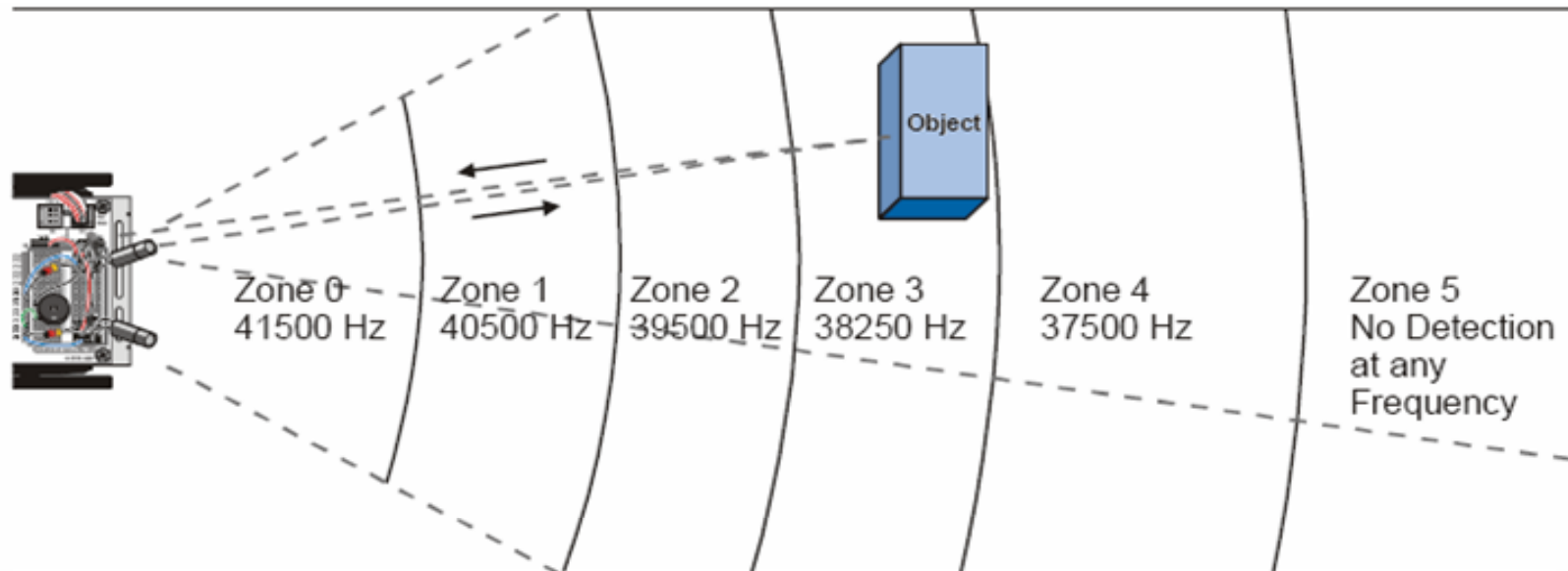


IR Sensor on the BoeBot

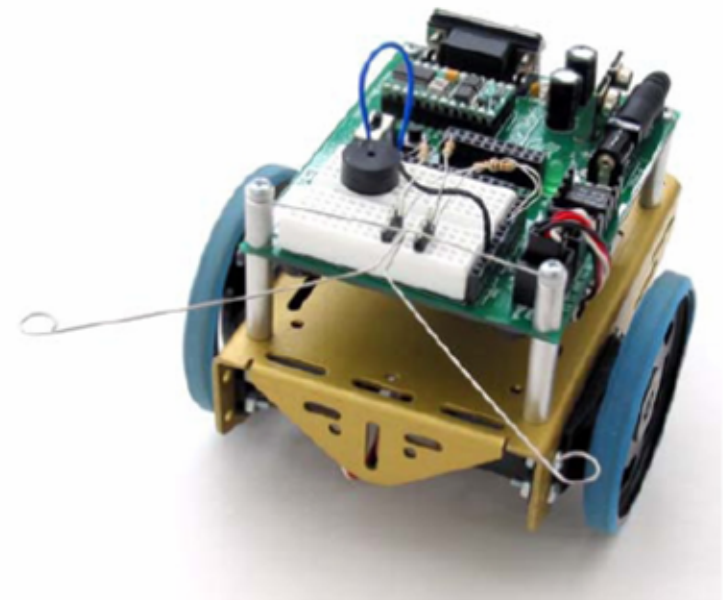
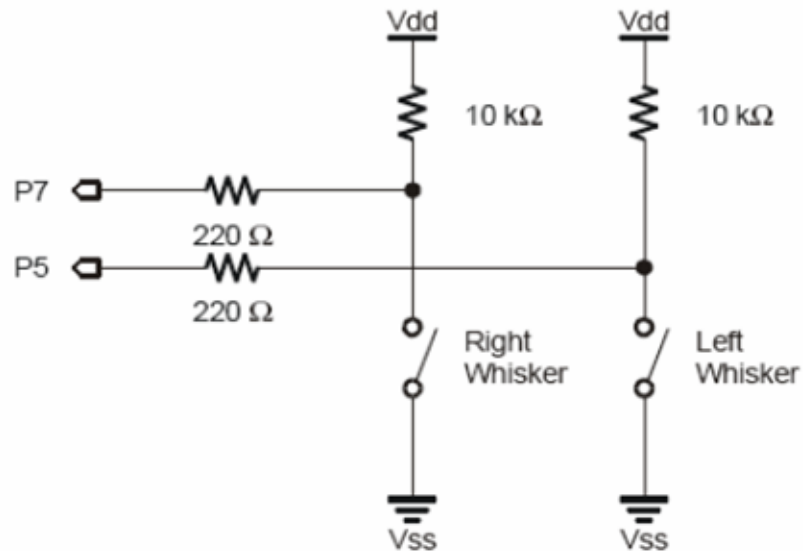


- Detects obstacles
- Detects distance
- Freqout pin#, period, 38500
 - Freqout 7, 1, 38500
 - IR_Detect = in8

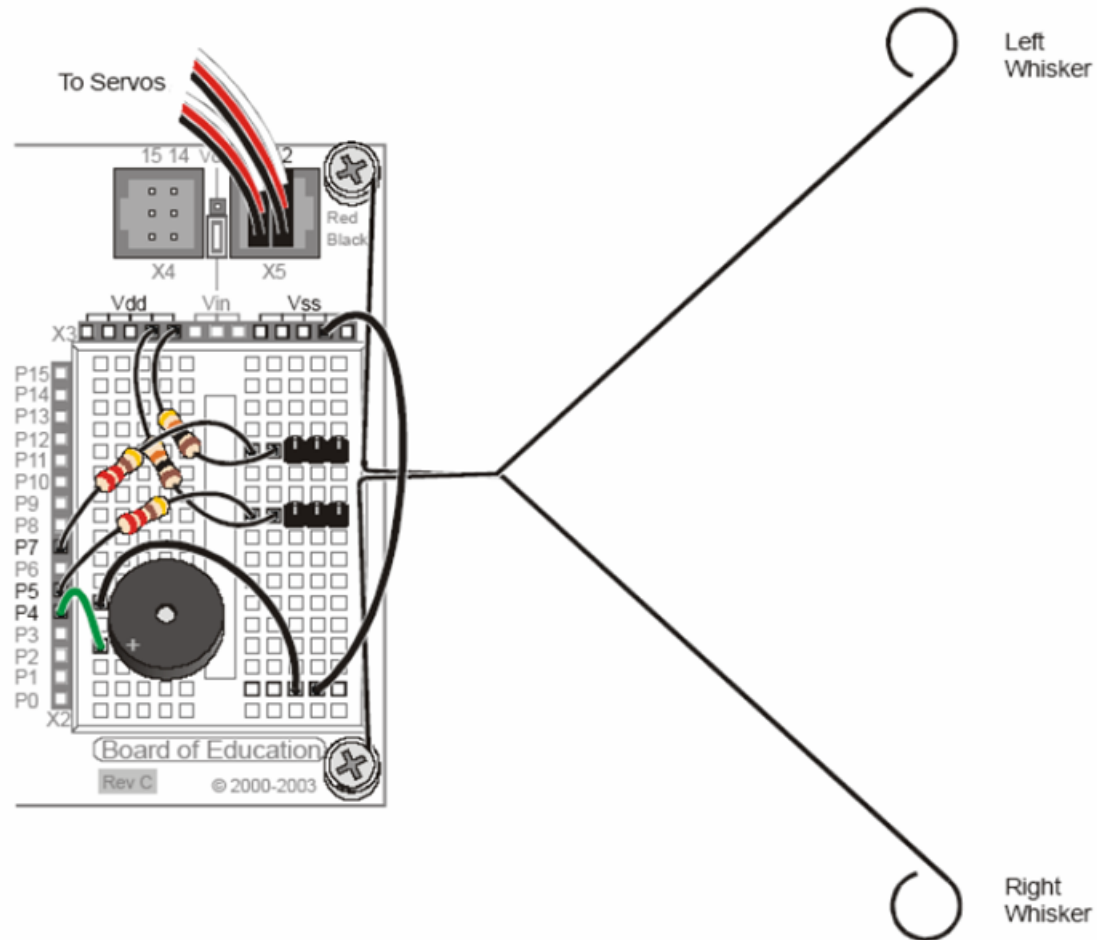
Distance Detection



Button Applications: Tactile Sensing —I

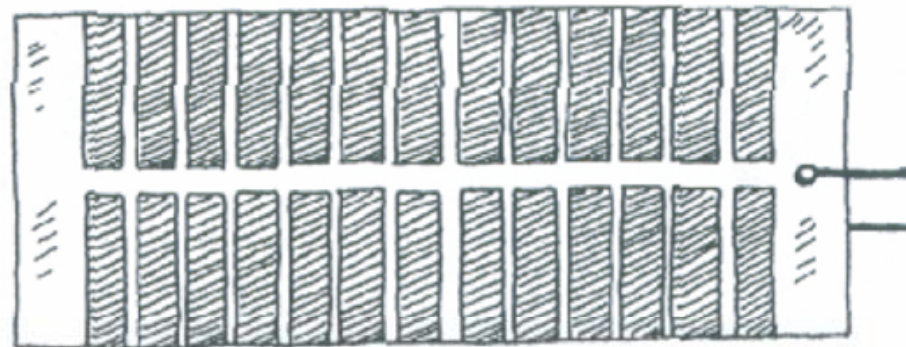
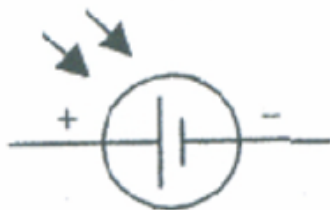


Button Applications: Tactile Sensing —II



Solar Cell—I

- Solar cells are photodiodes with very large surface areas.
- Compared to usual photodiodes, the large surface area in photodiode of a solar cell yields
 - a device that is more sensitive to incoming light.
 - a device that yields more power (larger current/volts).
- Solar cells yield more power.
- A single solar cell may provide up to 0.5V that can supply 0.1A when exposed to bright light.

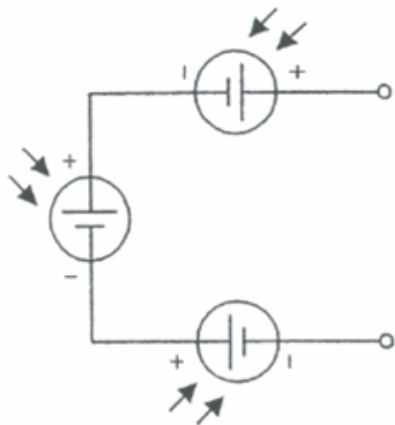


Solar Cell—II

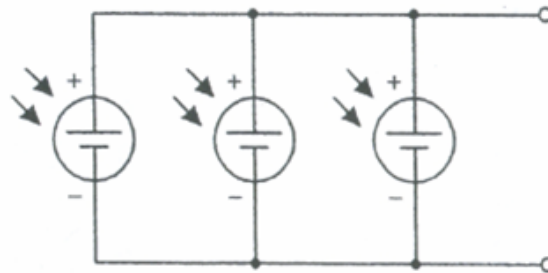


Solar Cell Basic Operation—Power Sources

INCREASED VOLTAGE

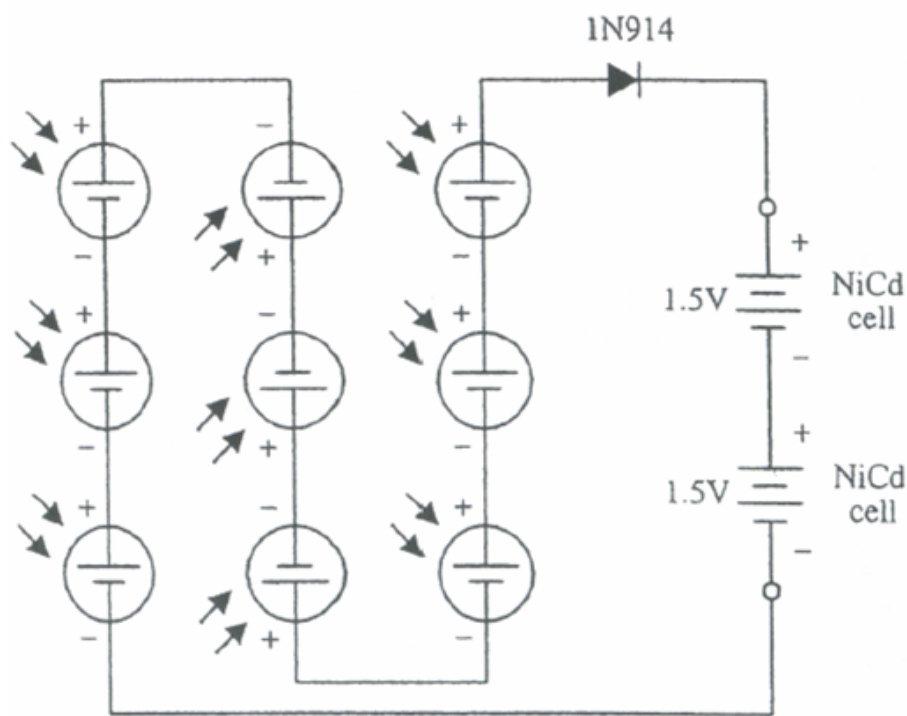


INCREASED CURRENT



- Each solar cell produces an open-circuit voltage from around 0.45 to 0.5V and may generate as much as 0.1A in bright light.
- Similar to batteries, solar cells can be combined in series or parallel.
- Adding cells in series, yields output voltage that is the sum of the individual cell voltages.
- Adding solar cells in parallel, yields an increased output current *vis-à-vis* a single solar cell.

Solar Cell Basic Operation—Battery Charger



- Nine solar cells placed in series can be used to recharge two 1.5 V NiCd cells.
- The diode is added to the circuit to prevent the NiCd cells from discharging through the solar cell during times of darkness.
- It is important not to exceed the safe charging rate of NiCd cells. To slow the charge rate, a resistor can be placed in series with the batteries.

IR Sensor Experiments

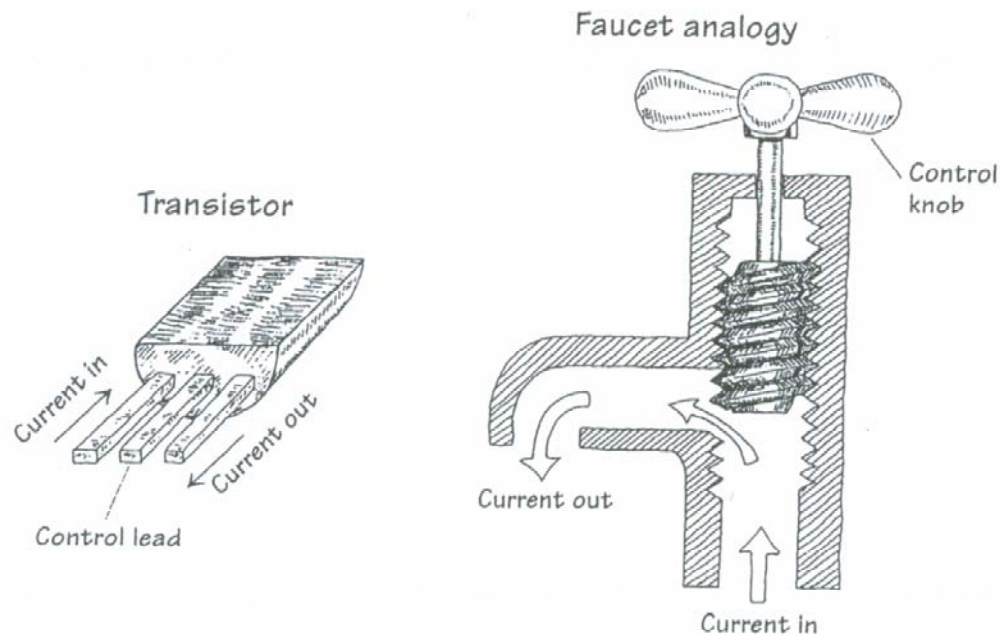
Experiments	Chapters
What's micro controller	
Basic A and D	
Process Control	
Boe Bot Robotics	7 and 8
Smart Sensors	
Others	

Lecture 13

Transistors

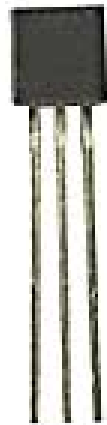
Transistor

- A semiconductor device that acts as
 - An electrically controlled switch
 - A current amplifier



BJT, JFET, and MOSFET

- **B**ipolar **J**unction **T**ransistor
 - NPN and PNP
- **J**unction **F**ield **E**ffect **T**ransistor
- **M**etal **O**xide **S**emiconductor **F**ET



BJT transistor



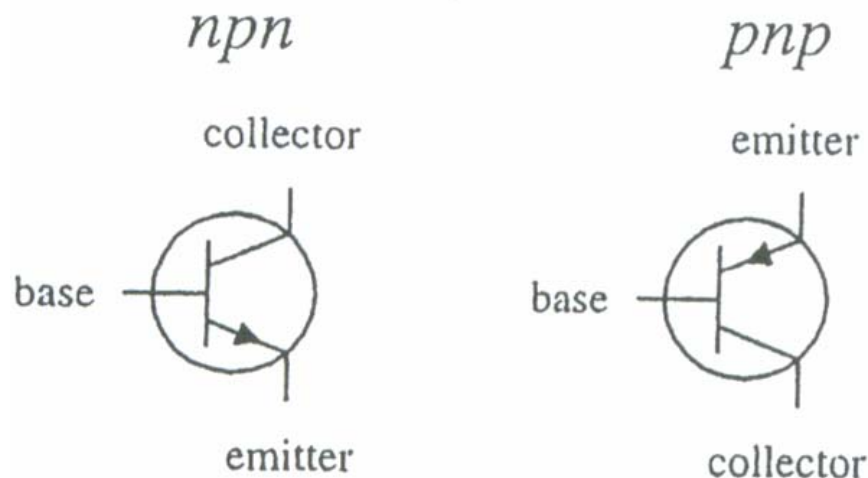
JFET



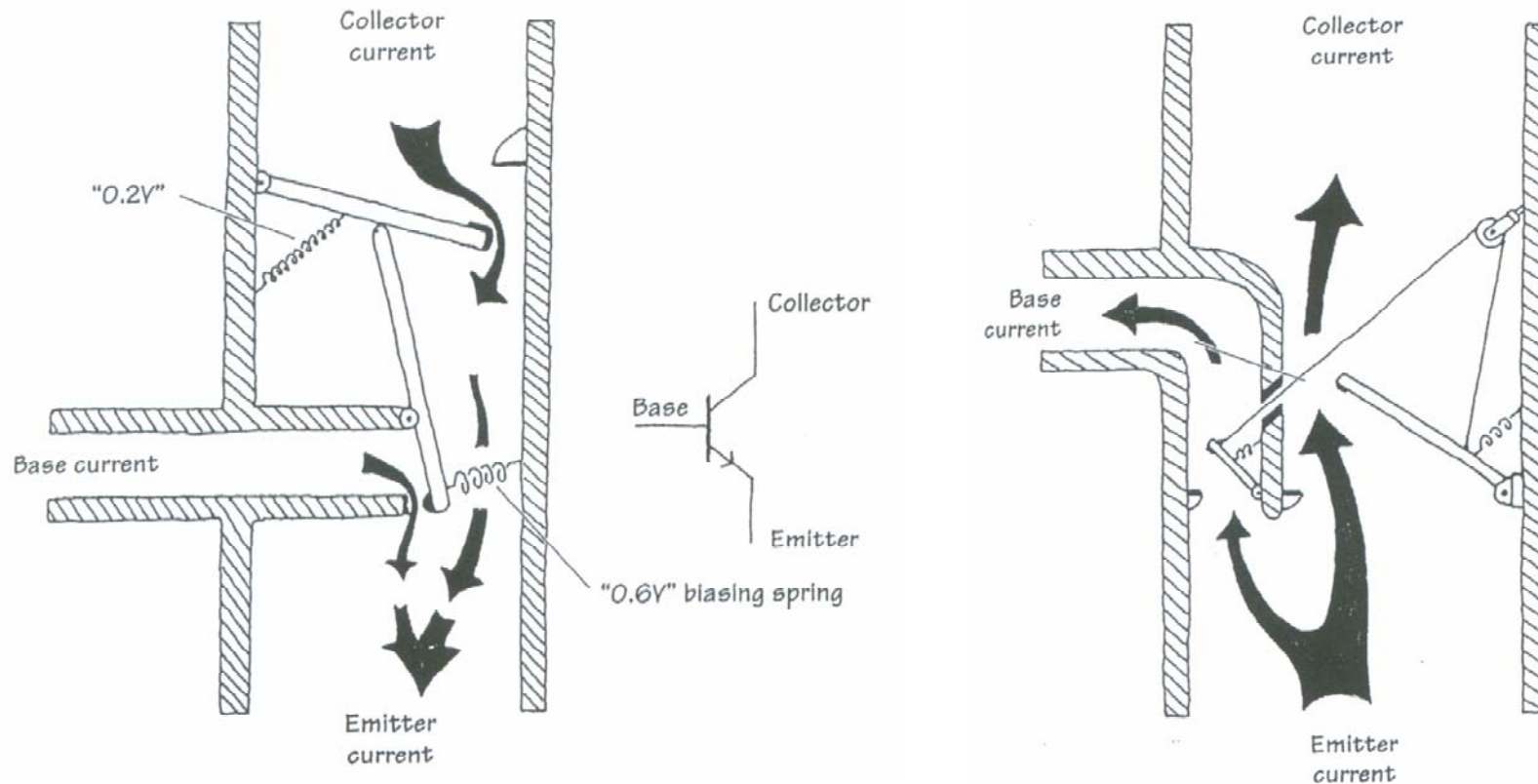
MOSFET

BJT

- NPN: a small input current and a positive voltage applied at base allows to flow from collector to emitter
- PNP: a small output current and a negative voltage at base allows a much larger current to flow from emitter to collector



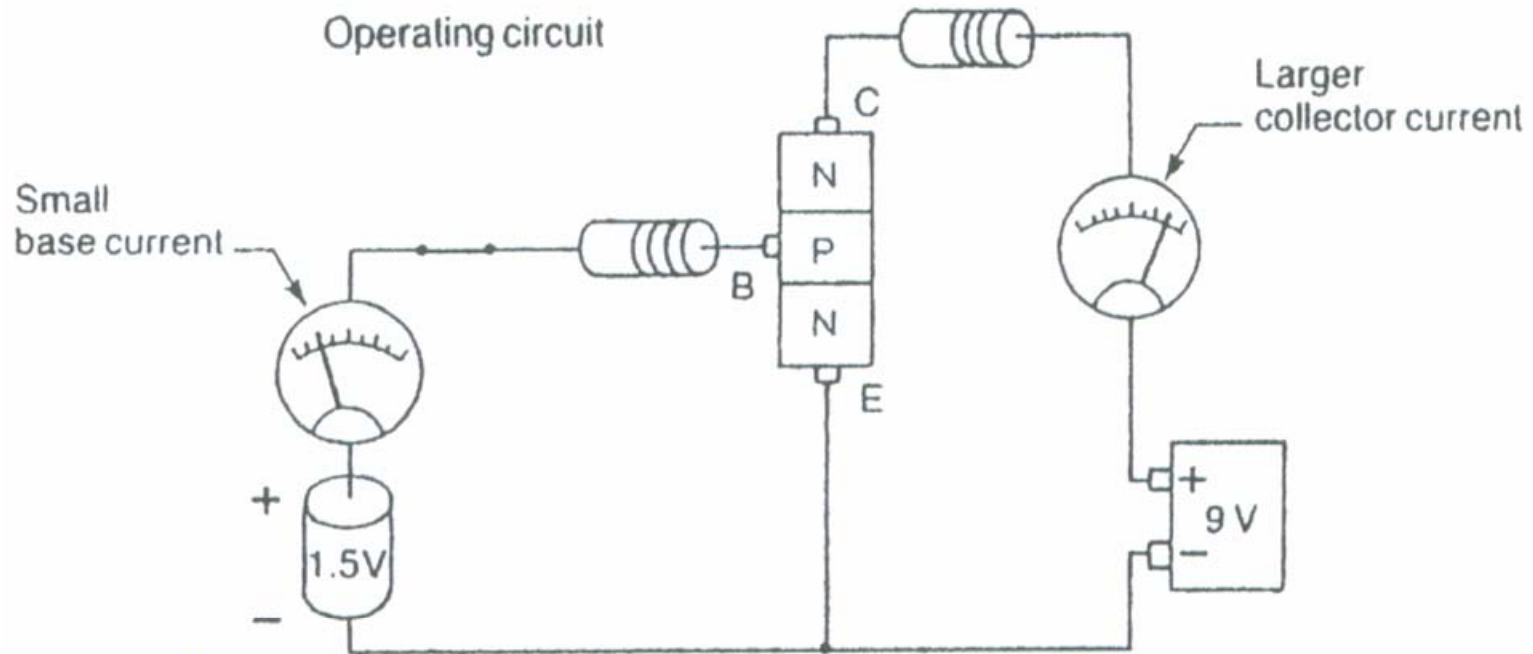
BJT Water Analogy



NPN ($V_B > V_E$)

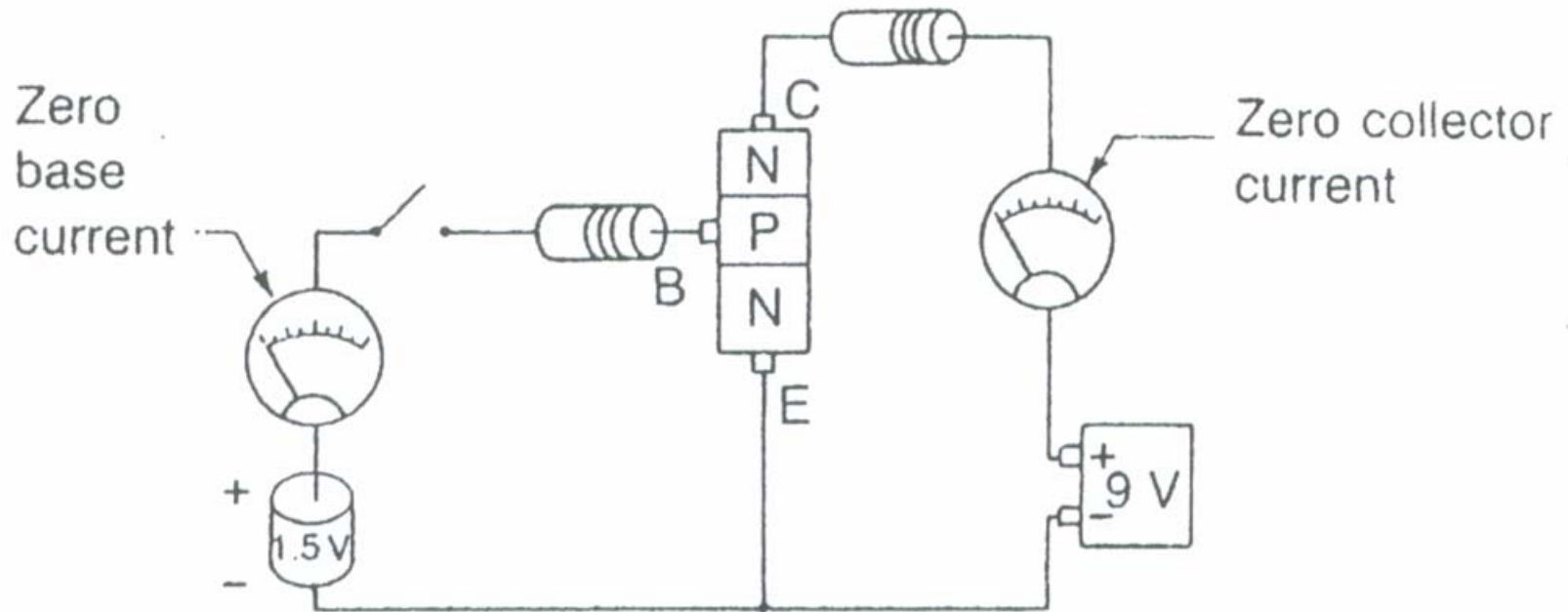
PNP ($V_B < V_E$)

NPN Transistor in a Circuit 1



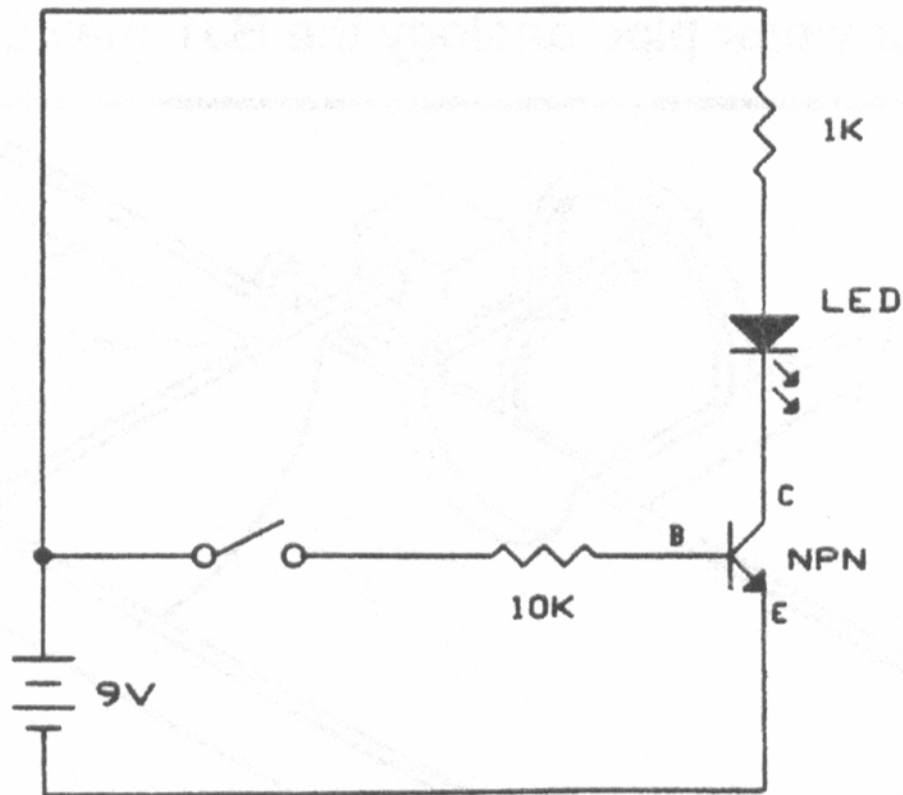
NPN ($V_B > V_E$)

NPN Transistor in a Circuit 2

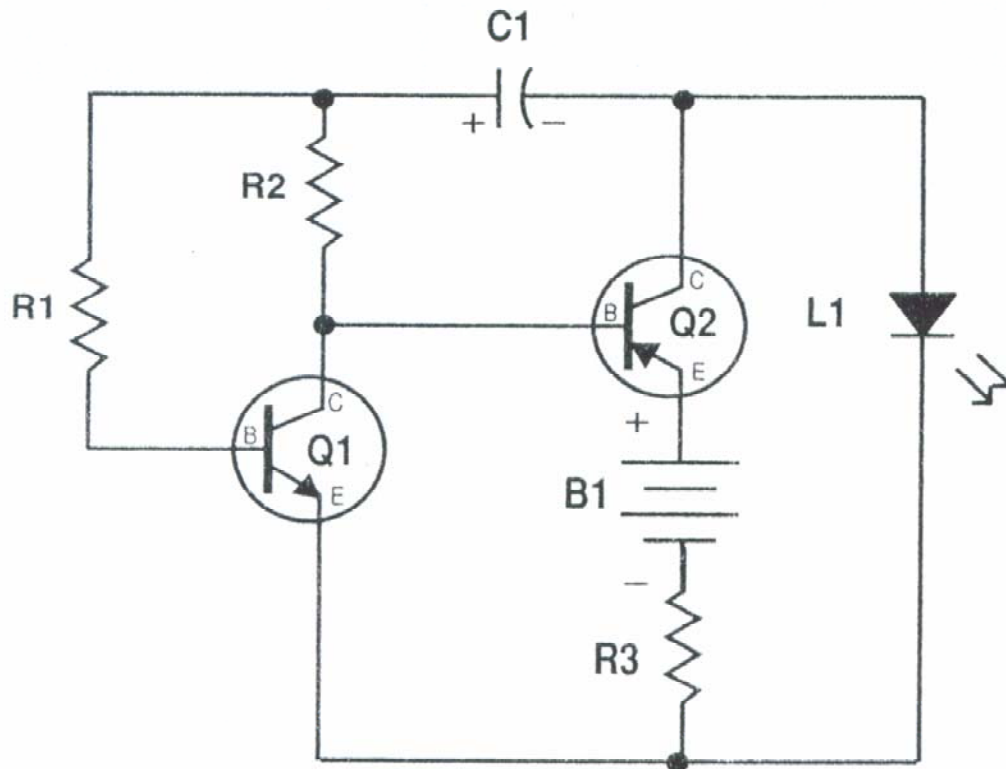


NPN ($V_B = V_E$)

Transistor Experiment 1



Transistor Experiment 2

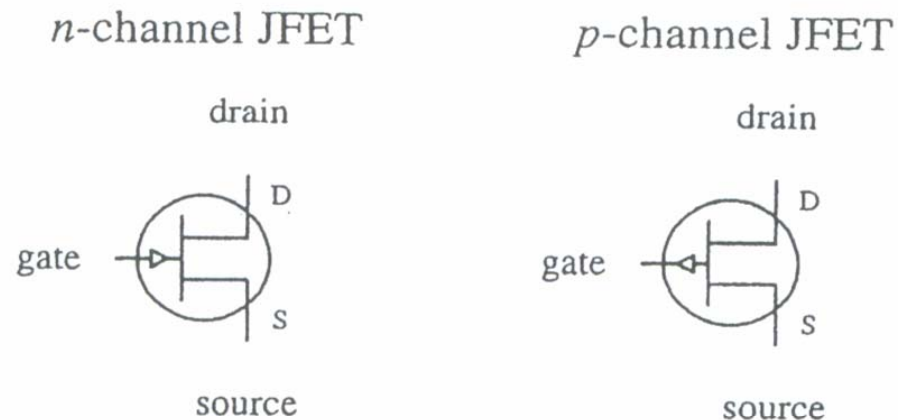


C1	1 μ F
L1	LED
Q1	NPN transistor
Q2	PNP transistor
R1	4.7k Ω
R2	10M Ω
R3	100 Ω

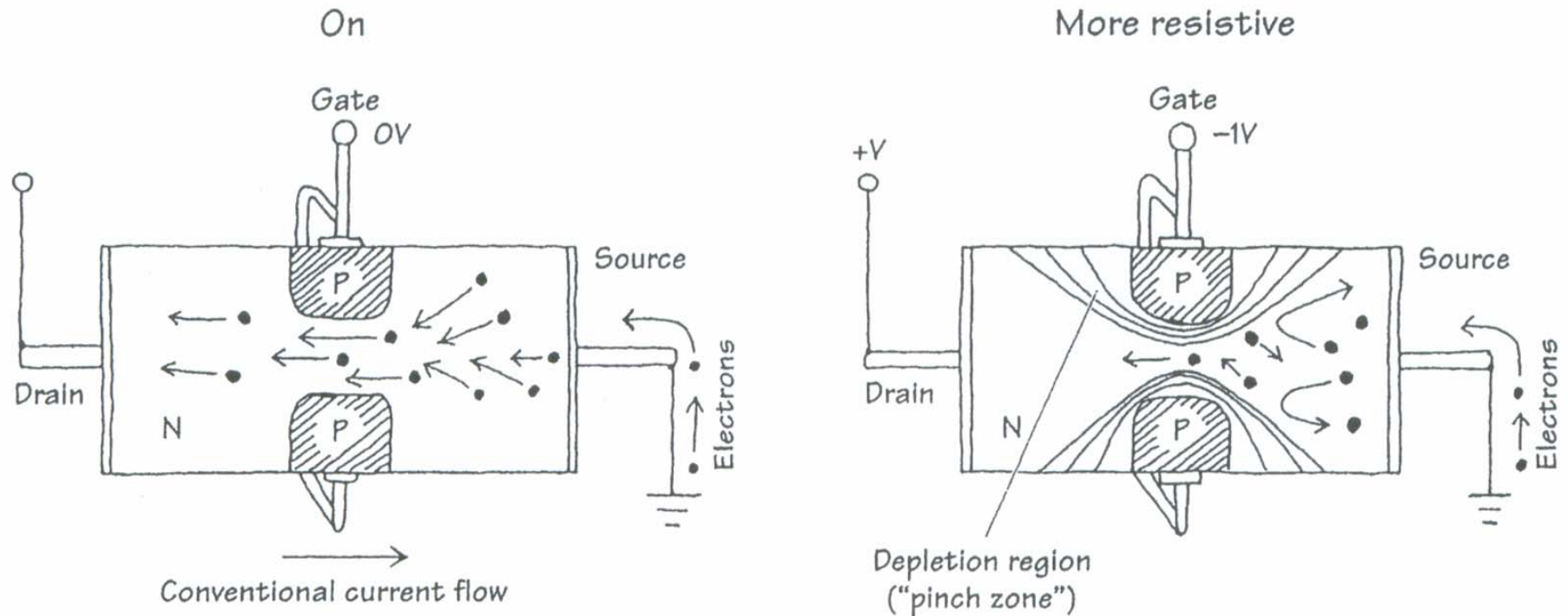
Oscillator

JFET

- Junction field effect transistor
- Electrically controlled switches
- Current amplifiers
- Voltage-controlled resistors
 - Do not require a bias current
- Normally on when $V_G - V_S = 0$

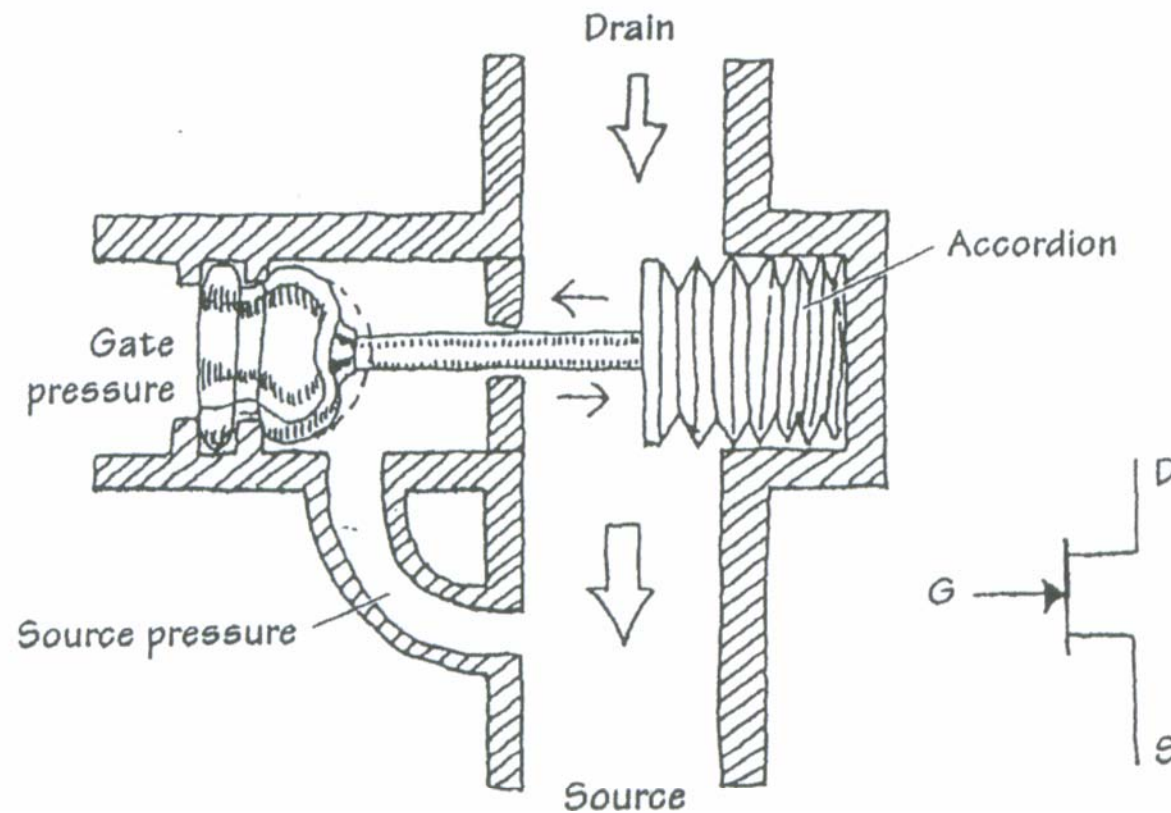


JFET: How It Works



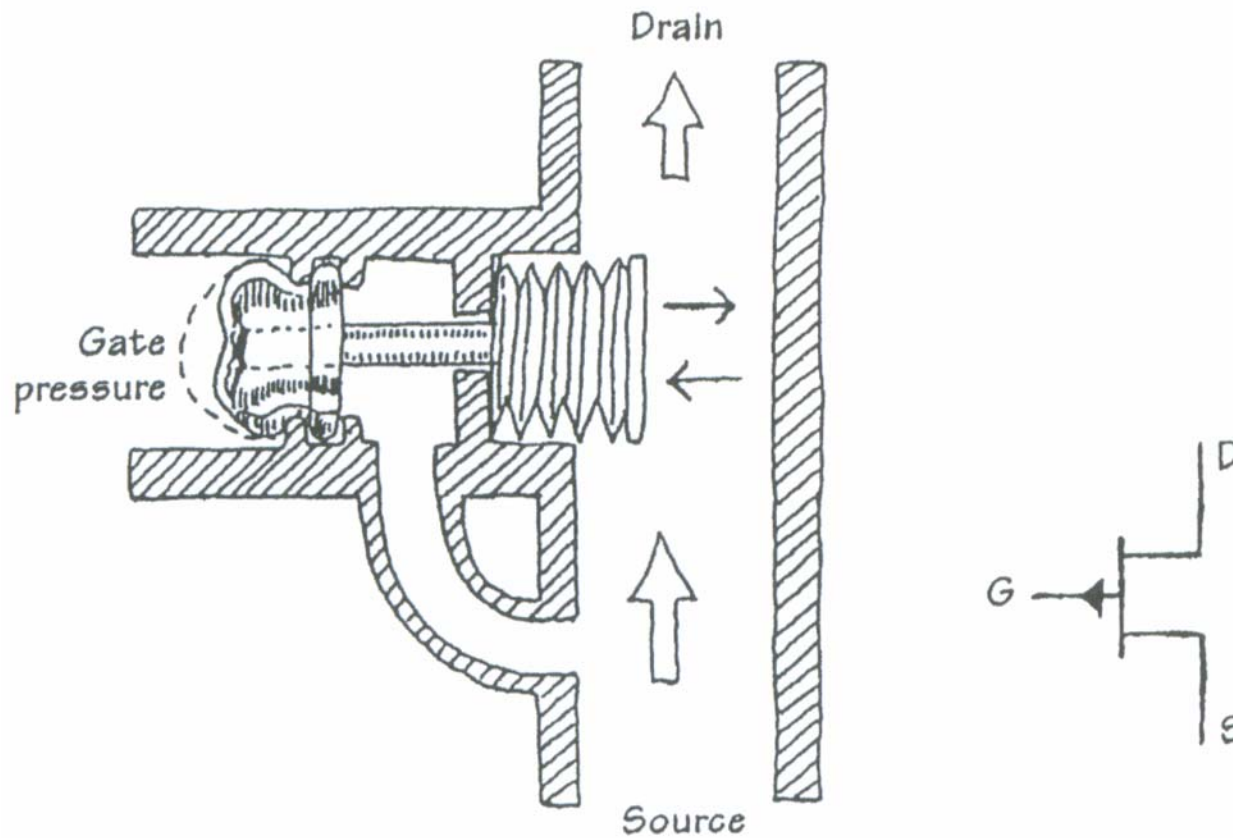
N-channel JFET: a negative voltage is applied at gate to reduce current flow from drain to source

JFET Water Analogy 1



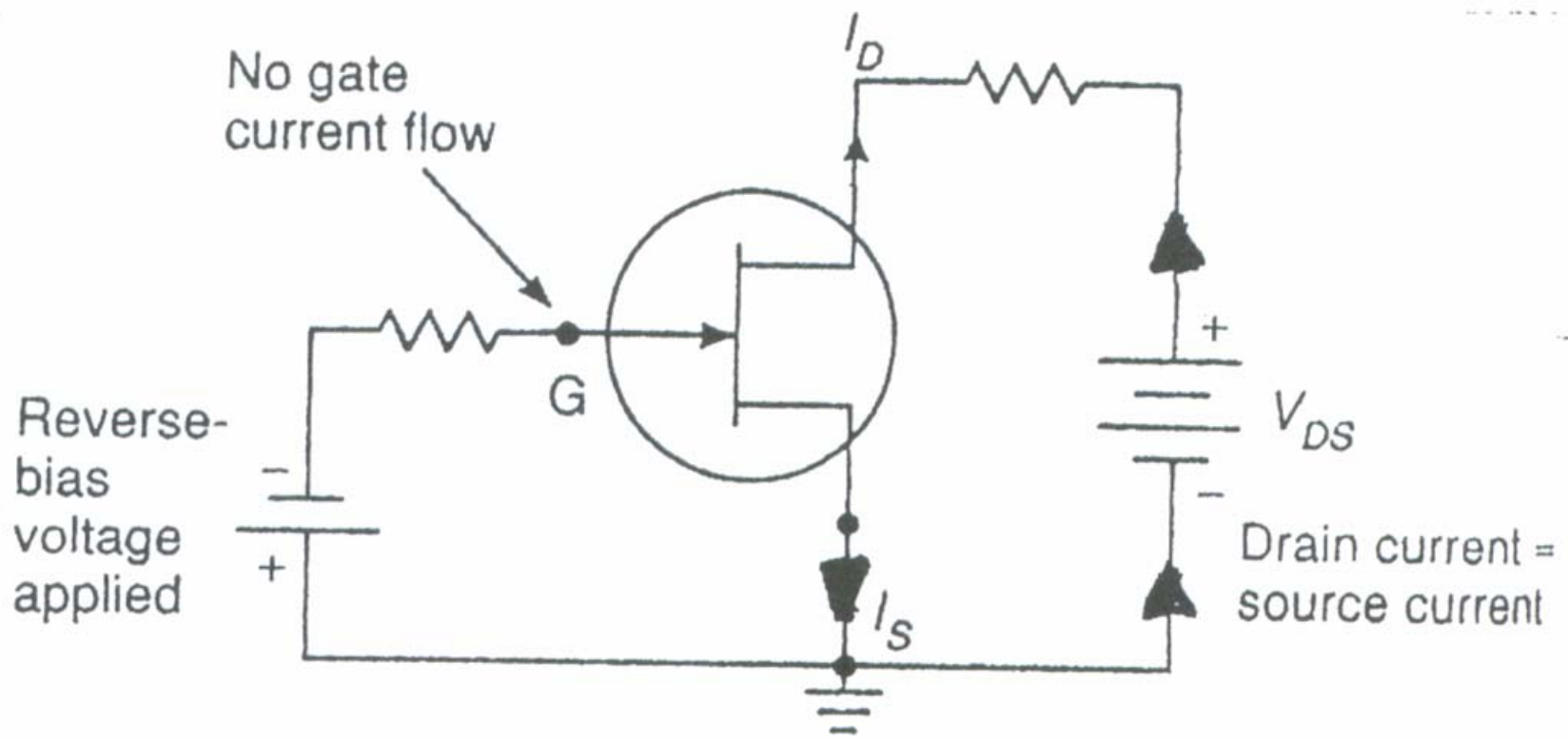
N-channel JFET

JFET Water Analogy 2

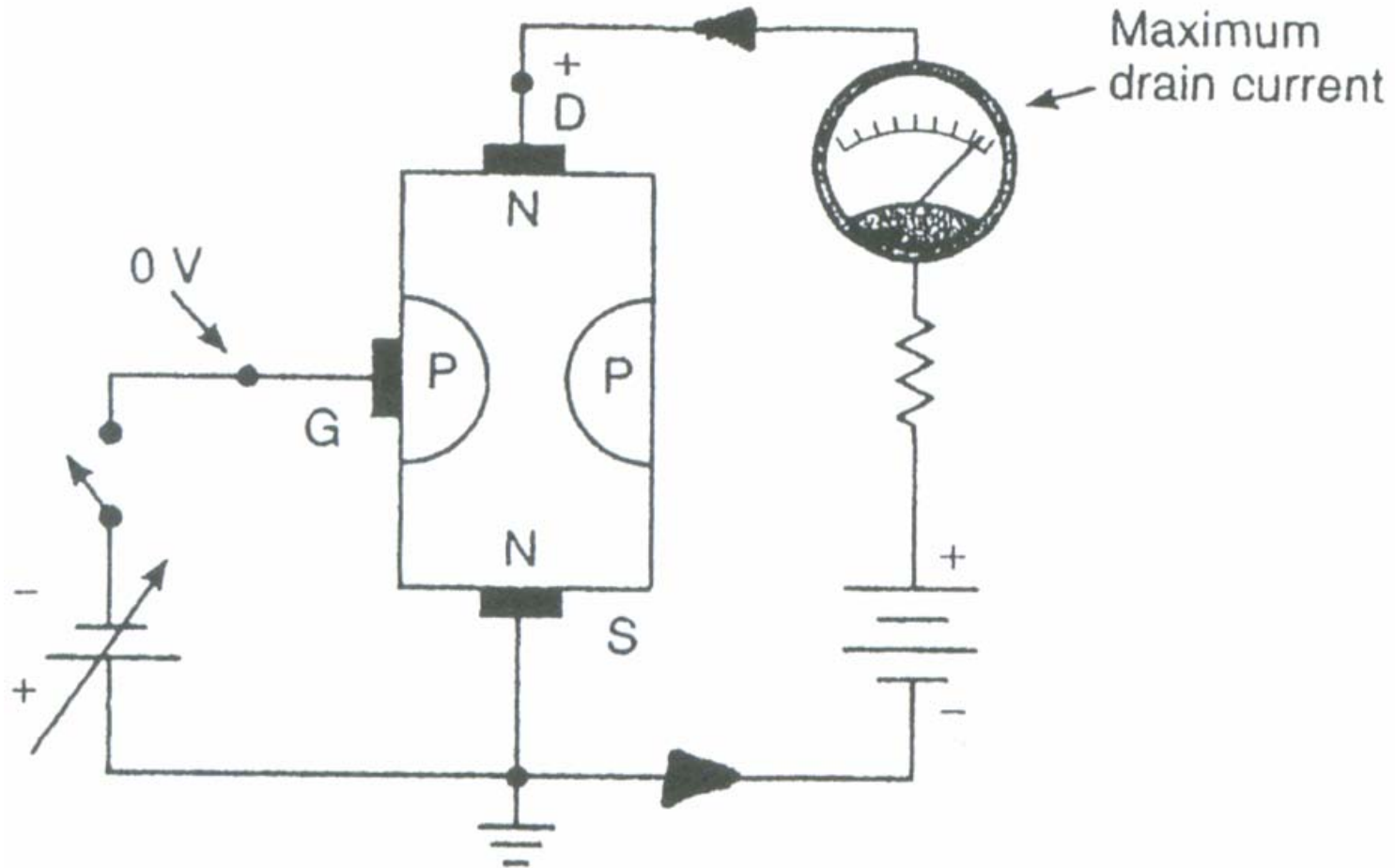


P-channel JFET

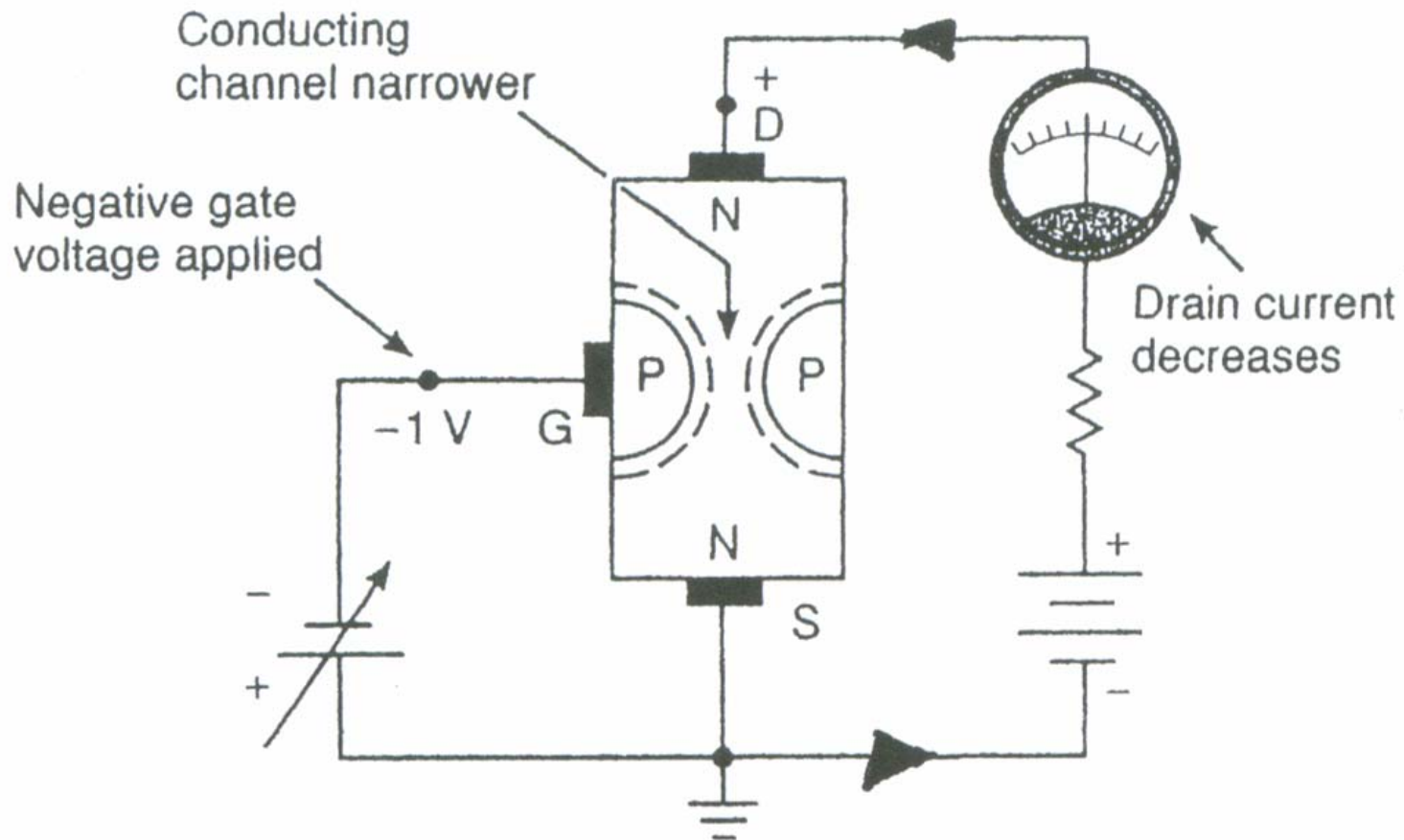
JFET Current



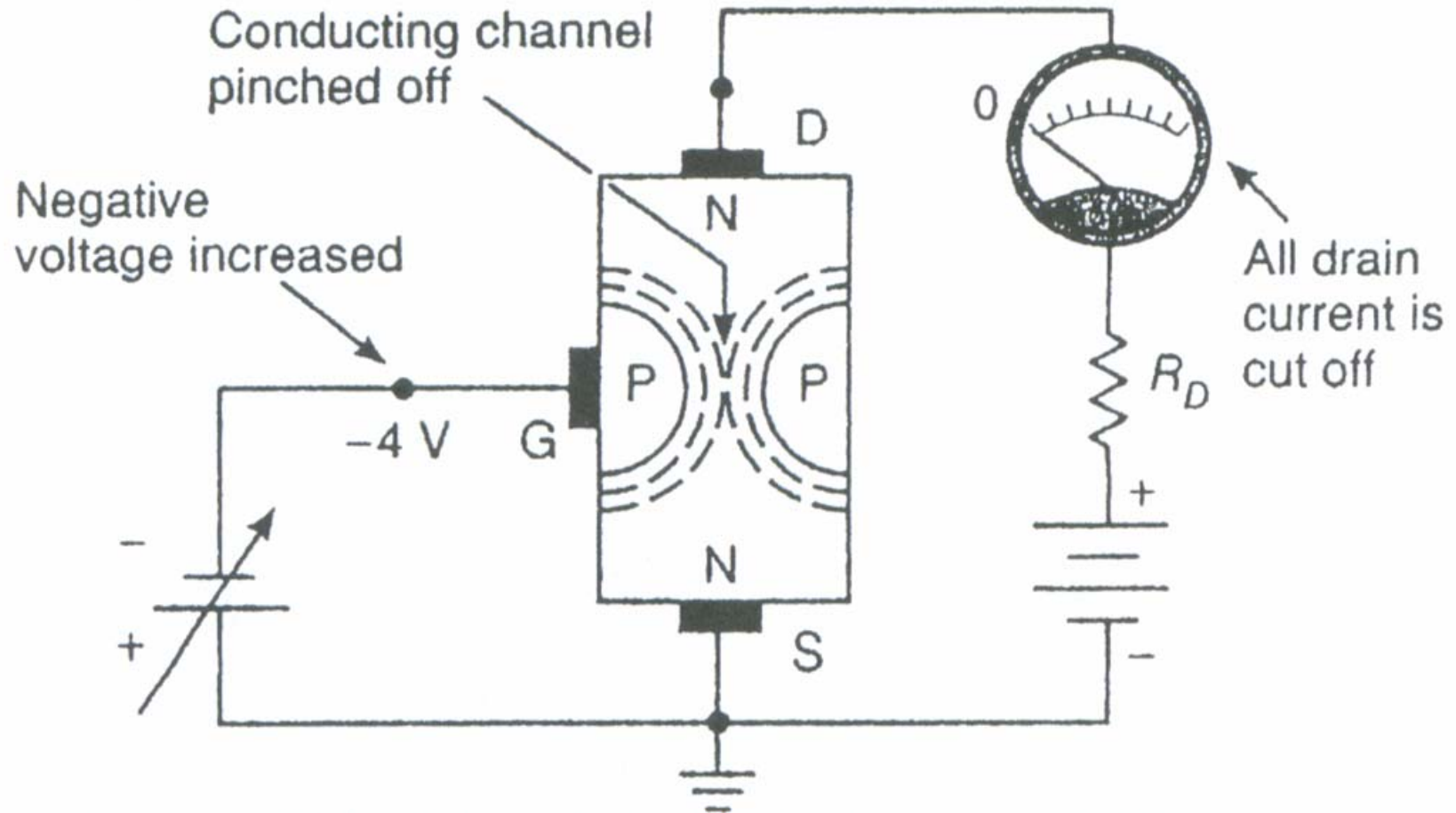
Full Current Passes



Reduced Current Passes



No Current Passes



MOSFET

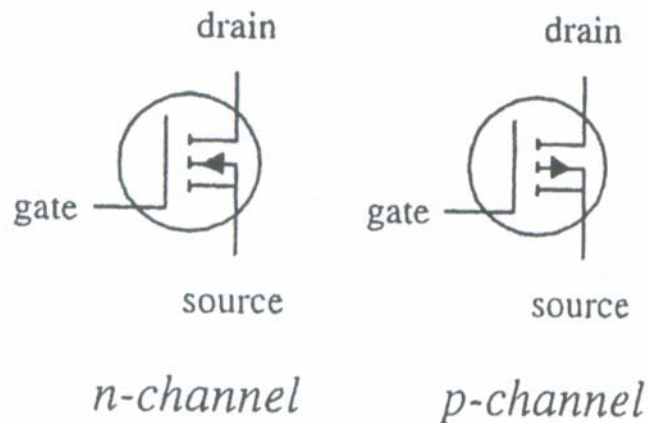
- Metal oxide semiconductor FET
- Similar to JFET
- High impedance ($10^{14} \Omega$)



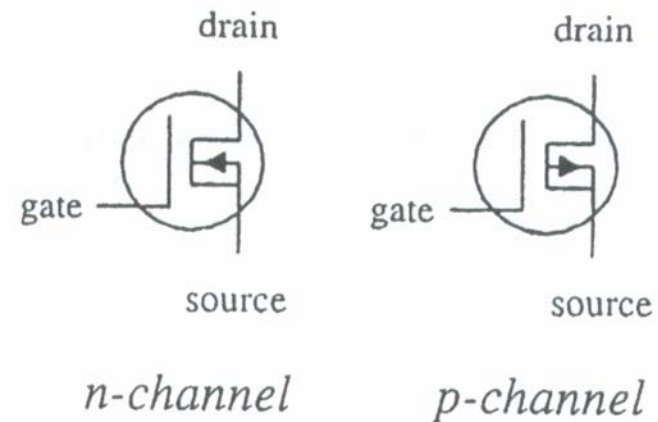
MOSFET Type

- Depletion type
 - Normally on ($V_G = V_S$)
- Enhancement type
 - Normally off

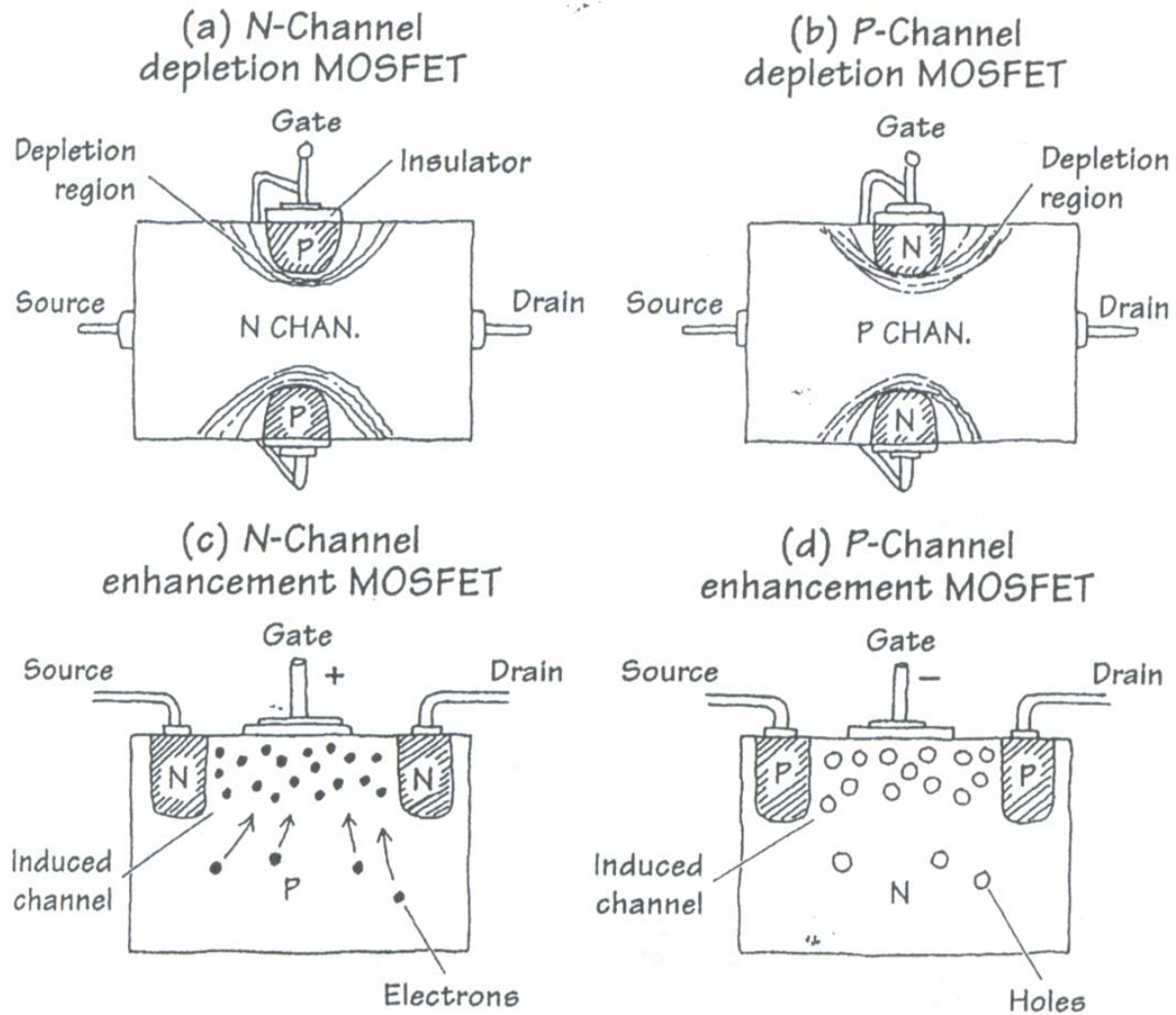
Enhancement MOSFETs



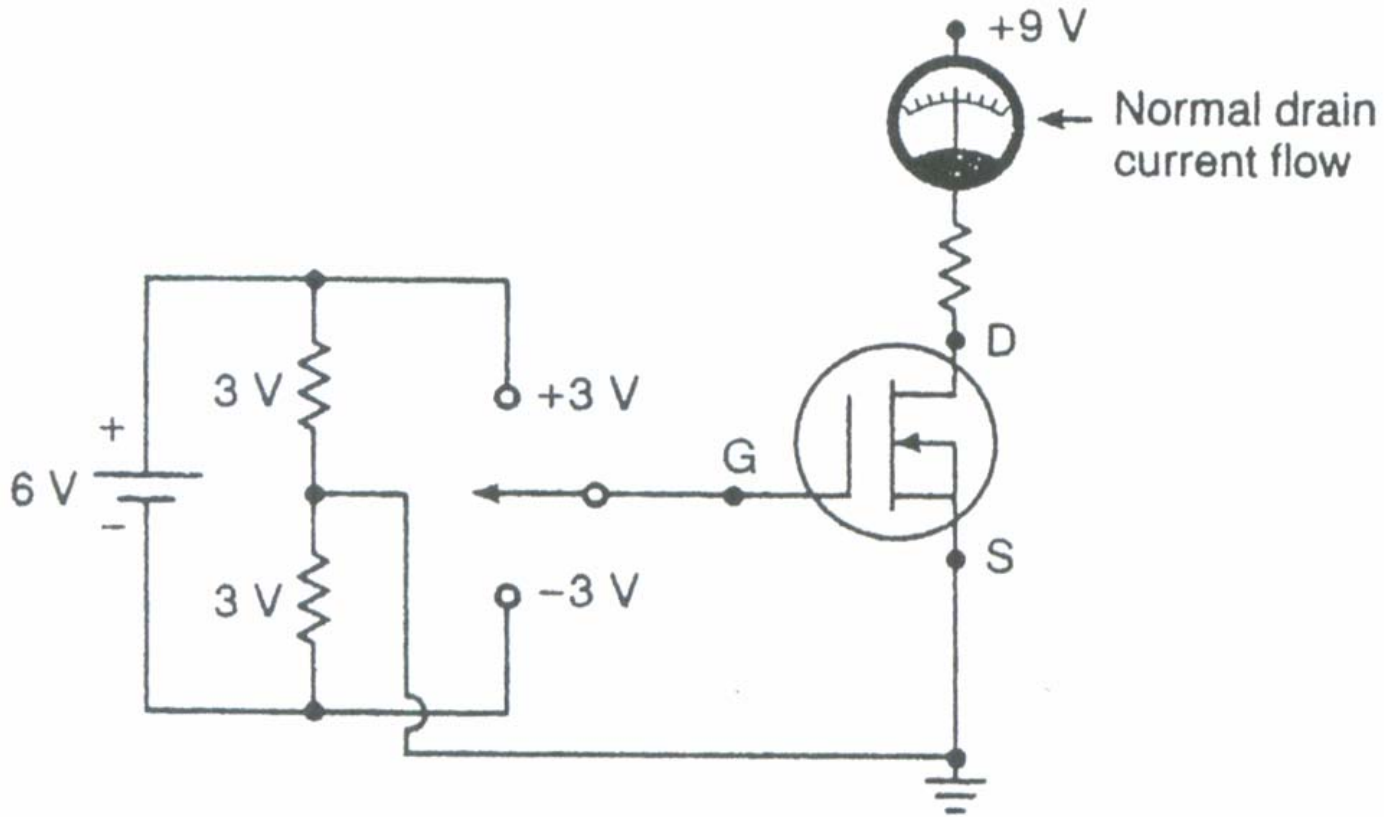
Depletion MOSFETs



MOSFET: How It Works

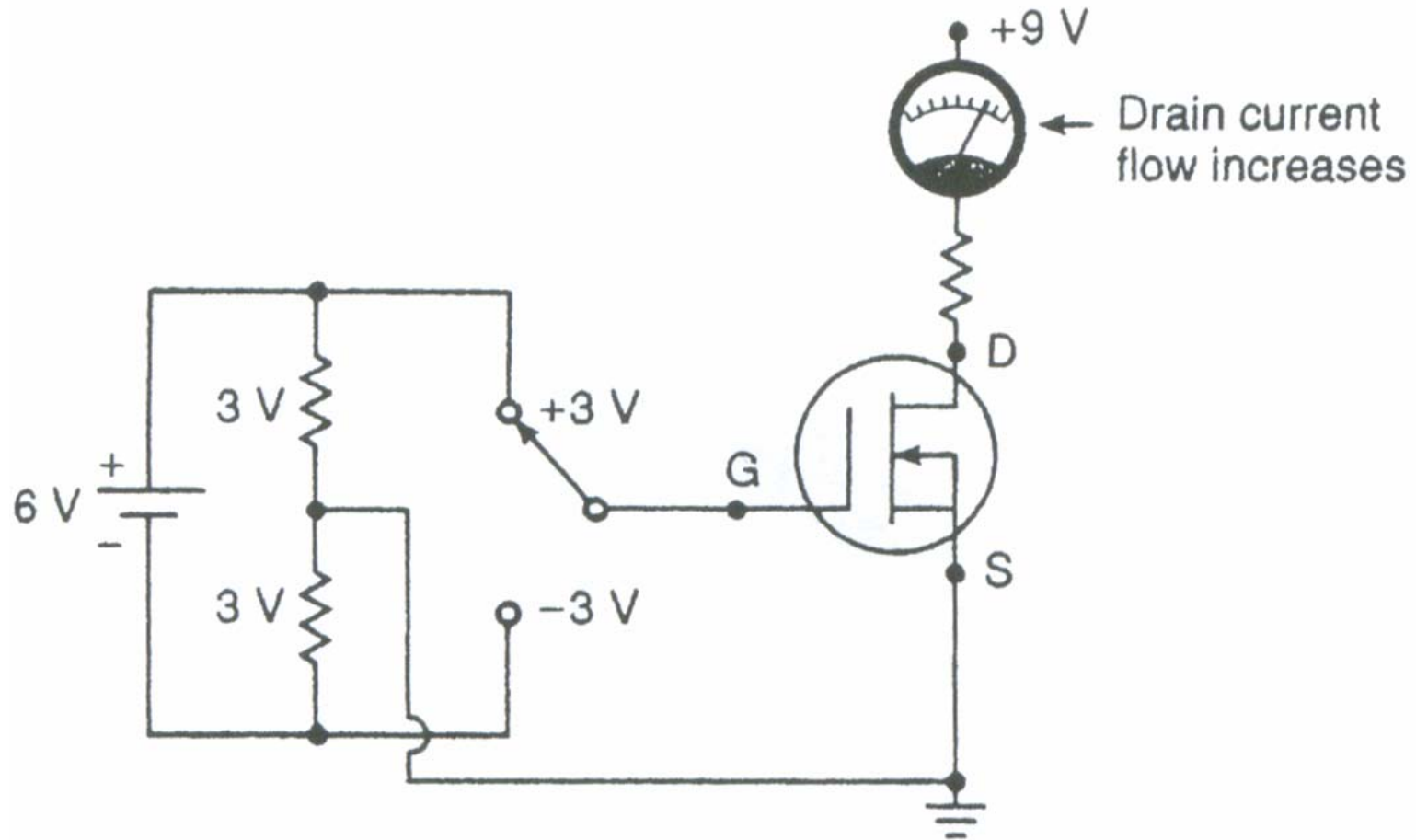


MOSFET Experiment 1



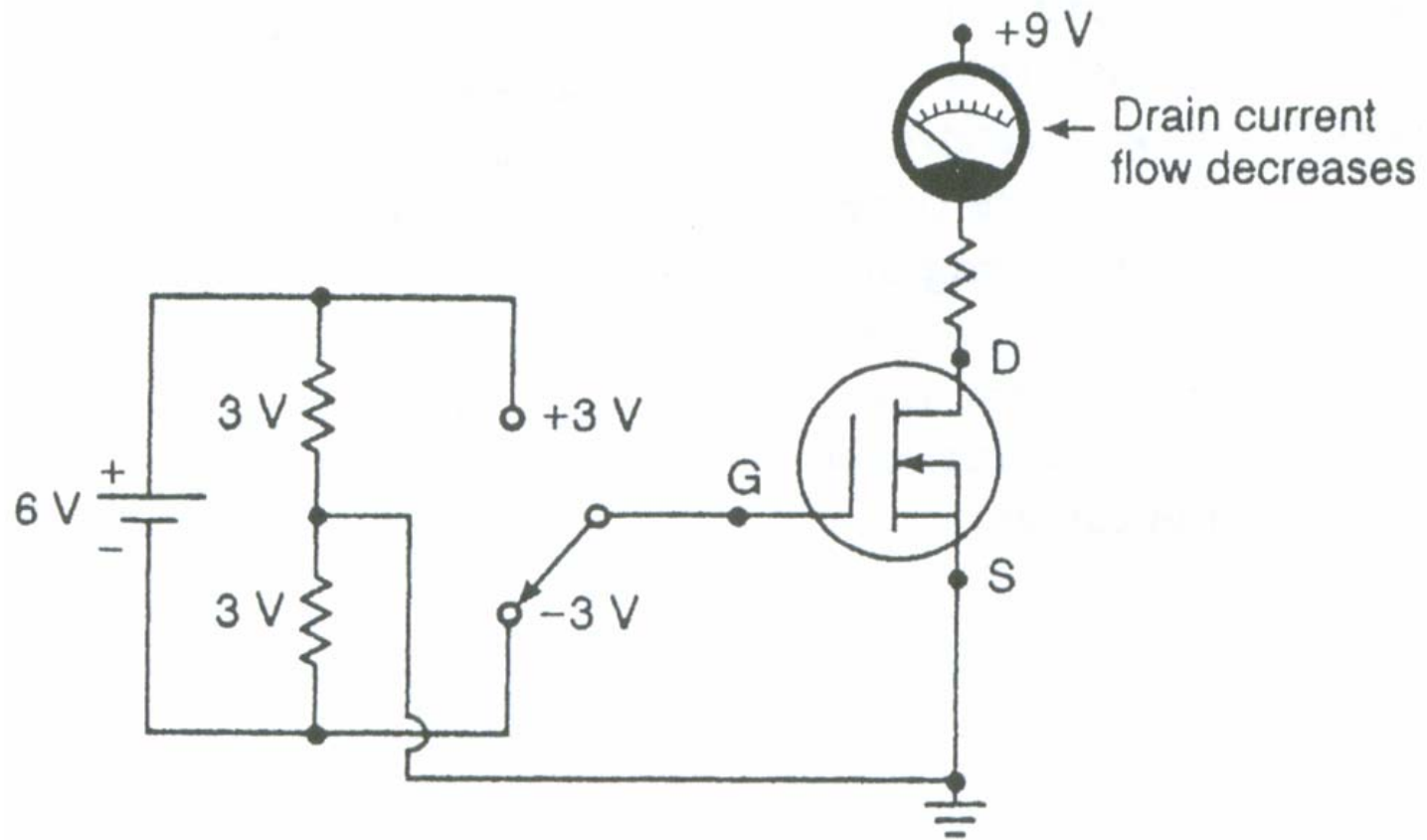
A. Zero gate-to-source voltage

MOSFET Experiment 2



B. Positive gate-to-source voltage

MOSFET Experiment 3



C. Negative gate-to-source voltage

Transistor Experiments

Experiments	Chapters
What's micro controller	
Basic A and D	
Process Control	
Boe Bot Robotics	
Smart Sensors	
Others	