CHAPTER 1

**1.1**

Answering machine

Alarm clock

Automatic door

Automatic lights

ATM

Automobile:

Engine controller

Temperature control

ABS

Electronic dash

Navigation system

Automotive tune-up equipment

Baggage scanner

Bar code scanner

NiCad/Lithium Ion battery chargers

Cable/DSL Modems and routers

Calculator

Camcorder

Carbon monoxide detector

Cash register

CD and DVD players

Ceiling fan (remote)

Cellular phones

Coffee maker

Compass

Copy machine

Cordless phone

Depth finder

Digital Camera

Digital watch

Digital voice recorder

Digital scale

Digital thermometer

Electronic dart board

Electric guitar

Electronic door bell

Electronic gas pump

Elevator

Exercise machine

Fax machine

Fish finder

Garage door opener

GPS

Hearing aid

Invisible dog fences

Laser pointer

LCD projector

Light dimmer

Keyboard synthesizer

Keyless entry system

Laboratory instruments

Metal detector

Microwave oven

Model airplanes

MP3 player

Musical greeting cards

Musical tuner

Pagers

Personal computer

Personal planner/organizer (PDA)

Radar detector

Broadcast Radio (AM/FM/Shortwave)

Razor

Satellite radio receiver

Security systems

Sewing machine

Smoke detector

Sprinkler system

Stereo system

Amplifier

CD/DVD player

Receiver

Tape player

Stud sensor

Talking toys

Telephone

Telescope controller

Thermostats

Toy robots

Traffic light controller

TV receiver & remote control

Variable speed appliances

Blender

Drill

Mixer

Food processor

Fan

Vending machines

Video game controllers

Wireless headphones & speakers

Wireless thermometer

Workstations

Electromechanical Appliances\*

Air conditioning and heating systems

Clothes washer and dryer

Dish washer

Electrical timer

Iron, vacuum cleaner, toaster

Oven, refrigerator, stove, etc.

\*These appliances are historically based only upon on-off (bang-bang) control. However, most high end versions of these appliances have now added sophisticated electronic control.

**1.2**



**1.3**



**1.4**

****

**1.5**

(a)



(b) 

**1.6**



**1.7**

****

**1.8** .

Although this distance corresponds to the diameter of only a few atoms, ITRS projections are on track to produce feature sizes in this range. See the Intel website for example.

**1.9**



**1.10** D, D, A, A, D, A, A, D, A, D, A

**1.11**

****

**1.12**



**1.13**



**1.14**



**1.15** (a) A 4 digit readout ranges from 0000 to 2000 and has a resolution of 1 part in 2,000. The number of bits must satisfy 2B ≥ 2,000 where B is the number of bits. Here B = 11 bits. (b) 2B ≥ 106 yields B = 20 bits.

**1.16**

****

**1.17**

IB = dc component = 7.50 mA, ib = signal component = 0.003 cos (1000t) A

**1.18**

VGS = 2.5 V, vgs = 0.5u(t-1) + 0.1 cos 2000t Volts

**1.19**

vCE = [5 + 2 cos (5000t)] V

**1.20**

vDS = [5 + 2 sin (2500t) + 4 sin (1000t)] V

**1.21**

 V = 1 V, R1 = 24 k, R2= 30 k and R3 = 11 k.



**1.22**

 V = 8 V, R1 = 30 k, R2= 24 k and R3 = 15 k.



**1.23**



**1.24**



**1.25**



To find the Thévenin equivalent resistance, we apply a test source to the output with vi set to zero:

 Thévenin equivalent circuit:



vi

39.8 



**1.26**

 Norton equivalent circuit:



2.01 x 10-3 vi

467 



To find the Thévenin equivalent resistance, we apply a test source to the output with vi set to zero:

 

**1.27**

(a) 







Noton equivalent circuit:



3.85 x 10-3 vi

100 k

(b)



ii



99300 ii

100 k



Rth is found in part (a).

**1.28**

(a)







Thévenin equivalent circuit:



89.6 vi

75 k

(b)



ii







Thévenin equivalent circuit:



74400 ii

75 k

**1.29**

(a) (b) 

(a) 

(b) Source is ii in part (b).



**1.30**



**1.31**



**1.32**



**1.33**



**1.34** (a) If the 36 k resistor was shorted, or the 82 k resistor was open, then the output voltage would be 0. If the 82 k resistor was shorted, the output would be 18 V (unless the 36 k resistor was also shorted. (b) If the 68 k resistor was shorted, or the 27 k resistor was open, then the output voltage would be +9 V. If the 27 k resistor was shorted, or the 68 k resistor was open, the output would be -9 V. Otherwise the voltage would be between –9 and +9 volts.

**1.35**



**1.36**





**1.37**



**1.38**

(a) 

(b) 

**1.39**



**1.40**

****

**1.41** Since the voltage across the op amp input terminals must be zero, v- = v+ and vo = vi.

Therefore Av = 1.

**1.42** Since the voltage across the op amp input terminals must be zero, v- = v+ = vi. Also, i- = 0.



**1.43**  Writing a nodal equation at the inverting input terminal of the op amp gives

****

**1.44**



|  |  |
| --- | --- |
| b1b2b3 | vO (V) |
| 000 | 0 |
| 001 | -0.625 |
| 010 | -1.250 |
| 011 | -1.875 |
| 100 | -2.500 |
| 101 | -3.125 |
| 110 | -3.750 |
| 111 | -4.375 |

**1.45 Low-pass amplifier**



**1.46 Band-pass amplifier**



**1.47 High-pass amplifier**



**1.48 Refers to Prob. 1.45**



**1.49**



**1.50** The gain is zero at each frequency: vo(t) = 0.

**1.51**

t=linspace(0,.005,1000);

w=2\*pi\*1000;

v=(4/pi)\*(sin(w\*t)+sin(3\*w\*t)/3+sin(5\*w\*t)/5);

v1=5\*v;

v2=5\*(4/pi)\*sin(w\*t);

v3=(4/pi)\*(5\*sin(w\*t)+3\*sin(3\*w\*t)/3+sin(5\*w\*t)/5);

plot(t,v)

plot(t,v1)

plot(t,v2)

plot(t,v3)

(a)

(b)

(c)

(d)

**1.52**



**1.53** 

**1.54** 

**1.55** 

Yes, the resistor is within the allowable range of values.

**1.56**

(a) 

V = 5.30 V exceeds the maximum range, so it is out of the specification limits.

(b) However, if the meter is reading 1.5% high, then the actual voltage would be



**1.57**



**1.58**



**1.59** I = 200 A, R1 = 150 k, R2 = 68 k and R3 = 82 k.



**1.60** V = 1 V, R1 = 24 k, R2 = 30 k and R3 = 11 k.





**1.61**



**1.62** For one set of 200 cases using the Equations in Prob. 1.59 (mA & k):



|  |  |  |  |
| --- | --- | --- | --- |
|  | I1 | I2 | V3 |
| Min | 89.9 A | 91.2 A | 7.34 V |
| Max | 110 A | 109 A | 9.23 V |
| Average | 100 A | 99.8 A | 8.23 V |

**1.63** For one set of 200 cases using the equations in Prob. 1.60.



|  |  |  |  |
| --- | --- | --- | --- |
|  | V1 | I2 | I3 |
| Min | 0.685 V | 6.70 A | 19.7 A |
| Max | 0.814V | 10.1 A | 27.1 A |
| Average | 0.754 V | 8.49 A | 22.9 A |

**1.64** 3.29, 0.995, -6.16; 3.295, 0.9952, -6.155

**1.65** (a) (1.763 mA)(20.70 k) = 36.5 V (b) 36 V

(c) (0.1021 A)(97.80 k) = 9.99 V; 10 V