```
##########################################
#       Modulated FM source for ECE 323
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#       Originated:     19JUL2003
#       Last Modified:  29JUL2003 = finish and documentation
#
#       file ece323_fm_src.sin
#
#       Based on equation 6.15b on page 283 of
#       Stremler,F.G. Introduction to Communication Systems 2nd Ed.
#       Addison-Wesley (C) 1982
#
#       Two connection points, both electrical
#               out - the output voltage
#               ref - the ground or reference
#       four parameters:
#               fcarrier - the carrier frequency in Hertz
#                       default value 10.9 megaHertz
#               fbaseband - the base band frequency in Hertz
#                       default value 2 kiloHertz
#               vhigh - maximum voltage output
#                       default value 1 volt
#               vlow -  minimum voltage output
#                       default value 0 volts
#               at default amplitude = 0.5 volts peak
#                          offset = 0.5 volts
#       (amplitude = (vhigh - vlow)/2,
#         offset   = (vhigh + vlow)/2)
#
#       See test circuit {below} for example useage
#
##########################################################
template ece323_fm_src out ref = fcarrier, fbaseband,vhigh, vlow
electrical out,ref
number fcarrier = 10.9meg,      \# carrier frequency  [Hz]
       fbaseband = 1k  ,        \# modulating signal  [Hz]
       vhigh   = 1     ,        \# peak positive output voltage [V]
       vlow    = 0              # lowest modulated output voltage [V]
{
<consts.sin
number wc,              \#      carrier frequency [rad/sec]
       wbase,           \#      modulating signal [rad/sec]
       vampl,           \#      amplitude [V]
       voffset =0,      \#      offset voltage [V]
       step ,           \#
```

```
        beta = 0.2      # modulation constant for narrow band FM
val     v       vout,           \#output voltage holder
                vantenna,       \# the fm signal
                vbase           # the baseband signal
var     i       i       #output current
parameters{
        wc = 2* math_pi * fcarrier      # convert Hertz to radians
        wbase = 2* math_pi * fbaseband
        step = 1/(fcarrier*20)  # set maximum step for carrier
        vampl = (vhigh-vlow)/2  #calculate peak to peak amplitude
        voffset =(vhigh + vlow)/2               #calculate offset
        }
values{
        if (time_domain){ # do this when in transient analysis
                step_size = step
                }
        vout = v(out)-v(ref)
        vbase = sin(wbase*time)
        vantenna = vampl*sin(wc*time + beta*vbase) +voffset
        }
equations{
        i(out->ref) += i
        i:vout = vantenna
        }
}
############################################################
#       Test Circuit
#       the frequency measured should vary from 10.492meg to 10.502meg
#       simulate for ts=2.857n, te = 2m
############################################################
# ece323_fm_src.tut out:v1 ref:0 = fcarrier=10.5meg, \
#                                  fbaseband=2k, \
#                                  vhigh = 1, \
#                                  vlow =-1
# r.load p:v1 m:0 = rnom = 1meg
# mfreq.check inp:v1 inm:0 out:freqval
```