ELEC271: Overview of module

Electronic Circuits

- Device model (hybrid-pi) – simple, linear - we can use it to help design and understand circuits

- 1-Transistor configurations – can amplify current and voltage etc. Use out model to analyse them to find key operation parameters BUT none are 'ideal'.

WHAT TO DO???

- Look at combining 1-T configurations - Take account of how one stage will 'load' another..

Start to see how ideal amplifier systems (IAS) might be built

- Need some more 'building blocks' – IAS must operate in the 'real world'
  differential amplifier (DA) can 'reject' interference (CMRR) – VERY USEFUL

- Look at simplest DA – all resistor biasing
  OK but problems as can't get high CMRR (depends on R_E) or high differential gain (depends on R_C) – biasing and ac performance too closely linked via R-values

- Replace simple R based current source with an active T one – also can temperature compensate!
  VERY IMPORTANT – AMPLIFIER SYSTEMS WILL BE ALL ON ONE PIECE OF SILICON (CHIP) SO POWER STAGES WILL HEAT UP CHIP – temperature gradients across chip!

- Look at other ways that the biasing can be done – simple ways of setting different bias currents for different parts of a circuit – currents mirrors, current repeater etc
  Also use small signal analysis to show that these current sources are close to ideal – ie have very high dynamic resistance

- Replace R-loads with **active loads** – current mirrors (so there are TWO uses for CMs)

- Now have very high gain, high CMMR diff amp – **MAJOR MILESTONE**

CASE STUDY: A COMMERCIAL OP-AMP (MOTOROLA – old design!)
- Can identify building blocks – amps., bias circuitry
- Can work out dc levels – so can get values for transistor ac parameters, gm, rbe
- Can work out ac gain of each stage taking into account loading effects

FIRST MAJOR ACHIEVEMENT OF THE MODULE
HAVE THE BASIC BUILDING BLOCKS – WILL NEED TO STUDY FEEDBACK **TO SEE HOW TO FINISH THE JOB OF MAKING IT AS NEAR TO IDEAL AS WE CAN**

- High frequency performance
  - Look at the highest frequency at which we can get useful current gain (f_T)
  - Look at voltage gain-bandwidth of common emitter amplifiers
  - Both analyses involve the parasitic capacitances within the device. We use some circuit tricks to simplify the analysis – reduce to simple first order RC response.

- MOS transistors – the building blocks of modern Integrated Circuits
- Step response – ie TRANSIENT response of circuits – time to 'switch on'

Electronic Systems

- Intro to negative feedback: appraise circuits by SPICE simulation – 'good' and 'poor' amplifiers

- 4 Types of amplifier – what makes an amp what it is! (summary table)
  - Voltage amp
  - Current amp
  - Transconductance amp
  - Transresistance amp

- Generic Equivalent circuits for each amp type – gain, R_{in}, R_{out}

- Relation between ideal amps and –ve feedback – types of feedback

- Identify Topology – output sensing – voltage and current / Input summing

- Derivation of feedback equation relating A_f, A_{ol}, β

  - A_f – gain with feedback
  - A_{ol} – open-loop gain

- Apply theory to analyse 4 amplifier types (assuming $A_f \sim 1/\beta$)

- Operational amplifiers – equivalent circuit (r_d, r_o, $A_{ol}V_d$)
  - VSP
  - Some circuit examples inc. the Analogue computer
  - Estimate R_{in} and R_{out} for non-inv. and inv. Op-amp circuits – use Equivalent circuit for an op-amp, some sensible approximations and simple (yes!) circuit analysis
  - Estimating the loop gain (inject a 'test signal' into loop) – should be large for a good amp. system

- Effect of feedback on
  - Bandwidth – effectively increases it
  - Distortion – effectively reduces it

- Model for op-amp including non-idealities:
  - Output Voltage offset

Input currents: Input bias current: $I_B = \frac{I_{BP} + I_{BN}}{2}$; 'input offset current' $I_{os} = |I_{Bp} - I_{Bn}|$

A method to work out a way of compensating for these offsets

CHECK PAST PAPERS TO SEE QUESTION STYLES