

Course Description: Study of frequency response, feedback and stability in amplifiers. Analysis and design of multi-stage amplifiers, wave generation and power circuits.

Pre-requisite: INEL 4201, INEL 4102

Textbook: Sedra, Adel S.; Smith, Kenneth C.; *Microelectronic Circuits, 6th Edition*, Oxford University Press, New York, 2010.

Primary objectives of course: To develop the ability to analyze and design wide band analog multi-stage amplifiers with and without feedback, as well as circuits based on operational amplifiers, active filters, and power amplifiers.

Professor Information:

- **Name:** Manuel Toledo **Office:** Stefani 409 **Email:** manuel.toledo1@upr.edu
- **Office hours:** Will be posted at <http://www.ece.uprm.edu/~mtoledo>
- **Course web page:** <http://www.ece.uprm.edu/~mtoledo/web/index-4202.html>

Course Examinations and Grading:

Evaluation will consist of three partial examinations (25% each), and a final exam (25%).

Course's Rules:

- Preliminary grade curve: 90-100 = A ; 80-89 = B ; 70-79 = C ; 60-69 = D ; 0-59 = F.
- The final exam will be optional. If taken the final exam's grade will replace the lowest partial exam grade.
- No reposition exams will be given.

Reference Books:

1. Microelectronic Circuit Design, Jaeger and Blalock, 2nd ed., McGraw Hill, 2004.
2. Engineering Electronics, Robert Mauro, Prentice Hall, 1989

Preliminary Schedule

| Lesson | TOPIC | Article | Problems |
|--------|---|-------------------|---|
| 1 | Introduction, frequency response, Bode plots | 1.6 | 1.(65, 66, 67) |
| 2 | Bypass and coupling capacitors | 9.1 | 9.(1, 3, 5, 11, 12, 14, 15) |
| 3 | BJTs and FET high frequency models | 9.2 | 9.(21, 25) |
| 4 | Common emitter and common source amplifiers, Miller's theorem | 9.(3-5) | 9.(33, 34, 38, 39, 60, 61, 64, 65, 68, 69) |
| 5 | CG/CB/CD and CC amplifiers | 9.(6-7) | 9.(76, 84,85, 86, 88, 89) |
| 6 | Multistage amplifiers, Effect of bandwidth on pulse response | 9.9, 9.10, App. E | 9.(102, 104, 108, 109, 112) |
| 7 | OpAmp inverting and non-inverting amps, summers, Integrators and differentiators, Applications. | 2.(1-5) | 2(1, 2, 8, 9, 11, 12, 16, 20, 22, 30, 44, 46, 49, 60, 62, 72, 74, 79, 80) |
| 8 | Review Exam I | | |
| 9 | Exam I | | |

| | | | |
|-----------|---|-----------------------|--|
| 10 | Feedback and its effect on gain, bandwidth and distortion; Classes of feedback amplifiers, effect of feedback on input and output impedance | 10.(1-3) | 10.(1,7,16,20, 27,28,30) |
| 11 | Feedback topologies. Analysis of feedback amplifiers with discrete devices | 10.(4-8) | 10.(31, 34, 35, 43, 46, 47) |
| 12 | Analysis of feedback amplifiers with discrete devices (cont.) | 10.(4-8) | 10.(53, 55, 57, 61, 65) |
| 13 | Analysis of feedback amplifiers with discrete devices (cont.) | | |
| 14 | Stability, gain and phase margins | 10.(9,10, 12) | 10.(89, 90, 92, 95, 96, 98) |
| 15 | Sinusoidal oscillators, RC oscillators | 17.(1,2) | 17.(9, 13, 14, 18) |
| 16 | LC Sinusoidal oscillators, quartz crystal oscillators | 17.3 | 17.(21, 22, 23) |
| 17 | Exam II | | |
| 18 | Current sources and differential amplifier | 7.(4,5) 8.(1-3, 5) | 7.(46, 47, 48, 55, 56, 58, 67, 70, 76, 77, 78) 8.(1, 2, 9, 25, 27, 29, 32, 33, 53, 60, 61, 62, 63, 64, 85, 91, 94, 102) |
| 19 | DC analysis of the 741 opamp | 12.(3,4) | 12.(23, 24, 25, 28, 29, 37, 39) |
| 20 | AC analysis of the 741 op-amp | 12.5 | 12.(42, 43, 47, 50) |
| 21 | Frequency response and slew rate | 12.6 | 12.(59, 62, 63) |
| 22 | CMOS opamp DC and AC analysis | 12.1 | 12.(2, 3, 5, 6) |
| 23 | Freq. resp. and slew rate of CMOS opamp | | 12.(9, 10, 11) |
| 24 | Folded cascode opamp | 12.2 | 12.(15, 16, 18, 19) |
| 25 | Exam III | | |
| 26 | Class A output stages, Class B and AB amplifiers, biasing. | 11.(1-5) | 11.(15, 19, 22, 23) |
| 27,28 | Power Amplifiers | Notes | |