GUJARAT TECHNOLOGICAL UNIVERSITY

BE-4 SEMESTER – OLD PAPER – S22 TO W25 – QUESTION BANK

Subject Name & Code:
Analog Circuit Design (3141002)

Unit 1: Transistor at High Frequencies

Repeated Questions:

1. **Derive the expression for the CE short-circuit current gain A_i as a function of frequency.**
   - Appeared in: S23 (Q2c, 07 marks), W23 (Q2c, 07 marks), S22 (Q2c, 07 marks)
2. **Explain the validity of the hybrid-π model.**
   - Appeared in: S23 (Q2a, 03 marks), W24 (Q1a, 03 marks)
3. **Derive the relationship between hybrid-π and h-parameters.**
   - Appeared in: S25 (Q5b, 04 marks), W25 (Q4c, 07 marks), S22 (Q4b, 04 marks)

Other Important Questions:

1. **List the parameters affecting the transistor at high frequencies.**
   - Appeared in: S23 (Q2b, 04 marks)
2. **Derive the high-frequency transconductance equation for g_m for CE amplifier.**
   - Appeared in: S25 (Q5c, 07 marks), S22 (Q5c, 07 marks)
3. **Derive the expression for gain-bandwidth product.**
   - Appeared in: S25 (Q5a, 03 marks)
4. **Derive the high-frequency current gain for CE amplifier with R_s.**
   - Appeared in: S25 (Q5c, 07 marks)
5. **Explain why junction capacitances exist in the hybrid-π model but not in the h-parameter model.**
   - Appeared in: W24 (Q1a, 03 marks)
6. **Derive the input conductance for the hybrid-π model in CE configuration.**
   - Appeared in: W24 (Q2c, 07 marks)
7. **Derive the base-spreading resistance for the hybrid-π model in CE configuration.**
   - Appeared in: W24 (Q2c OR, 07 marks)
8. **Explain how and why transconductance varies with $|I_c|$, $|V_{CE}|$, and temperature at high frequency.**
   - Appeared in: W23 (Q1b, 04 marks)
9. **Derive the emitter diffusion capacitance in terms of base width, diffusion constant, and transconductance.**
   - Appeared in: W23 (Q2c OR, 07 marks)

Unit 2: Oscillators

Repeated Questions:

1. **Explain the Barkhausen criterion for oscillation.**
   - Appeared in: S25 (Q2a, 03 marks), W24 (Q3b, 04 marks), W23 (Q4b, 04 marks)
2. **Explain the working of a crystal oscillator.**
   - Appeared in: S23 (Q2c OR, 07 marks), S22 (Q2b, 04 marks)
3. **Sketch the circuit of a phase-shift oscillator using BJT and obtain its frequency of oscillation.**
   - Appeared in: S23 (Q1c, 07 marks)
4. **Derive the expression for the frequency of oscillation of a Wien bridge oscillator.**
   - Appeared in: W24 (Q3c, 07 marks), W23 (Q3c, 07 marks), S22 (Q4c, 07 marks)

Other Important Questions:

1. **Explain the phase-shift oscillator using op-amp in detail.**
   - Appeared in: W25 (Q4b, 04 marks), W22 (Q4b, 04 marks)
2. **Define lock range, capture range for PLL, and frequency stability for oscillators.**
   - Appeared in: S22 (Q4a, 03 marks), W25 (Q3a, 03 marks), W22 (Q3a, 03 marks)
3. **Give a full classification of oscillators.**
   - Appeared in: W24 (Q4a, 03 marks), W23 (Q5b, 04 marks)
4. **Discuss the factors affecting the stability of oscillators.**
   - Appeared in: W24 (Q4b, 04 marks)
5. **Calculate the frequency of oscillations for an RC phase-shift oscillator given R=10KΩ, C=0.1μF.**
   - Appeared in: W23 (Q5a, 03 marks)
6. **In a Colpitts oscillator, C1=0.2μF, C2=0.02μF. If the frequency required is 10kHz, find the value of the inductor.**
   - Appeared in: W23 (Q4a, 03 marks)
7. **Explain the working of a 555 timer-based astable multivibrator.**
   - Appeared in: S25 (Q2c OR, 07 marks), S22 (Q2c OR, 07 marks)
8. **Explain the working of a 555 timer-based monostable multivibrator.**
   - Appeared in: S25 (Q2c, 07 marks)

Unit 3: Feedback Amplifiers

Repeated Questions:

1. **Compare and contrast the effects of negative and positive feedback on amplifier performance.**
   - Appeared in: S23 (Q3a, 03 marks)
2. **List and explain characteristics of an amplifier that are modified by negative feedback.**
   - Appeared in: S23 (Q3c, 07 marks)
3. **Draw the four types of feedback amplifier topologies.**
   - Appeared in: S23 (Q3b, 04 marks)

Other Important Questions:

1. **Explain the advantages of negative feedback in amplifiers.**
   - Appeared in: S22 (Q4b, 04 marks)
2. **Derive the expression for output resistance for a current-series feedback amplifier using BJT.**
   - Appeared in: W24 (Q3c, 07 marks)
3. **A CE amplifier with un-bypassed emitter resistance providing current series feedback is to be designed for $g_m = -1mA/V$, $A_v = -4$, and desensitivity = 50. Given $R_s = 1K\Omega, h_{fe} = 150$, find R_e, R_L, R_i', I_c.**
   - Appeared in: W23 (Q3c, 07 marks)
4. **Derive expressions for voltage gain and input resistance with feedback for an emitter follower circuit.**
   - Appeared in: W23 (Q5c, 07 marks)
5. **Compare voltage-series feedback amplifiers with current-series feedback amplifiers.**
   - Appeared in: W24 (Q3b, 04 marks)
6. **Compare current-series feedback with current-shunt feedback.**
   - Appeared in: W23 (Q3b, 04 marks)

Unit 4: Operational Amplifiers

Repeated Questions:

1. **Draw the schematic diagram of the op-amp and its equivalent circuit.**
   - Appeared in: S23 (Q1b, 04 marks)
2. **Explain the concept of virtual ground in an op-amp.**
   - Appeared in: S25 (Q4a, 03 marks), S22 (Q3a, 03 marks), W24 (Q2b, 04 marks), W23 (Q2b, 04 marks)
3. **List the ideal characteristics of an op-amp.**
   - Appeared in: S25 (Q1b, 04 marks), S22 (Q1a, 03 marks), W24 (Q4a, 03 marks), W23 (Q1a, 03 marks), W22 (Q2a, 03 marks)

Other Important Questions:

1. **Explain the internal block diagram of an op-amp.**
   - Appeared in: S25 (Q1a, 03 marks)
2. **Define: SVRR, slew rate, input offset voltage, input bias current, input offset current, CMRR, output offset voltage.**
   - Appeared in:
     - S25 (Q1c, 07 marks)
     - S23 (Q1a, 03 marks)
     - S22 (Q1b, 04 marks)
     - W25 (Q1a, 03 marks)
     - W24 (Q2a, 03 marks)
     - W23 (Q4a, 03 marks)
     - W22 (Q1a, 03 marks)
3. **Explain summing, scaling, and averaging amplifier.**
   - Appeared in: S25 (Q4b, 04 marks), S22 (Q3b, 04 marks)
4. **Explain differential amplifier using two op-amps.**
   - Appeared in: S25 (Q4b OR, 04 marks), S22 (Q5a, 03 marks), W22 (Q1c, 07 marks)
5. **Explain subtractor using op-amp.**
   - Appeared in: W25 (Q2b, 04 marks)
6. **Explain V to I converter with grounded load.**
   - Appeared in: S25 (Q3a, 03 marks)
7. **Explain floating load V to I converter using op-amp.**
   - Appeared in: W22 (Q4a, 03 marks)
8. **Explain I to V converter using op-amp.**
   - Appeared in: W25 (Q4a, 03 marks)
9. **Explain the basic differentiator using an op-amp. What are the problems? How are they overcome?**
   - Appeared in: S22 (Q1c, 07 marks)
10. **Derive the expression for the output of a differentiator circuit using op-amp.**
    - Appeared in: W24 (Q4b, 04 marks)
11. **Explain an inverting differentiator circuit using op-amp.**
    - Appeared in: W22 (Q2c, 07 marks)
12. **Derive gain expression for inverting and non-inverting configuration of op-amp.**
    - Appeared in: S25 (Q5b, 04 marks), W25 (Q2a, 03 marks), W24 (Q5b, 04 marks)
13. **Draw and explain VTC (Voltage Transfer Curve) of op-amp.**
    - Appeared in: W25 (Q1b, 04 marks), W22 (Q1b, 04 marks)
14. **Explain op-amp functionality as a comparator.**
    - Appeared in: W25 (Q1c, 07 marks)
15. **Explain window detector using op-amp.**
    - Appeared in: S22 (Q2a, 03 marks)
16. **Explain Schmitt trigger circuit using op-amp.**
    - Appeared in: W25 (Q5a, 03 marks), W22 (Q3b, 04 marks)
17. **Explain instrumentation amplifier circuit operation using op-amp.**

- Appeared in: W22 (Q2c OR, 07 marks)

18. **Explain sample and hold circuit using op-amp.**
    - Appeared in: S23 (Q4b, 04 marks), S22 (Q5a OR, 03 marks), W25 (Q2c, 07 marks), W22 (Q4a OR, 03 marks)
19. **Explain peak detector circuit using op-amp.**
    - Appeared in: S25 (Q5a, 03 marks), W25 (Q2c OR, 07 marks), S22 (Q5b OR, 04 marks)
20. **Explain voltage limiter circuit using op-amp.**
    - Appeared in: S25 (Q4a OR, 03 marks), W25 (Q4a, 03 marks)
21. **Explain half-wave rectifier circuit using op-amp.**
    - Appeared in: W22 (Q5a OR, 03 marks)
22. **Derive gain expression for voltage series feedback amplifier using op-amp.**
    - Appeared in: W22 (Q2b, 04 marks)
23. **For a non-inverting op-amp summing circuit with inputs 1V, 2V, 3V, Rf=2KΩ, Ri=1KΩ, determine output voltage.**
    - Appeared in: W23 (Q5b, 04 marks)
24. **Explain a circuit made up of op-amp that does scaling of inputs.**
    - Appeared in: W25 (Q3a, 03 marks)
25. **Explain a circuit made up of op-amp that does averaging of inputs.**
    - Appeared in: W22 (Q3a, 03 marks)

Unit 5: Specialized ICs and Applications

Repeated Questions:

1. **Explain the block diagram and working of IC 555 timer.**
   - Appeared in: W25 (Q5c, 07 marks)
2. **Explain monostable multivibrator using IC 555.**
   - Appeared in: W22 (Q5c OR, 07 marks), W24 (Q5c, 07 marks)
3. **Explain astable multivibrator using timer IC.**
   - Appeared in: W22 (Q5c, 07 marks)

Other Important Questions:

1. **What is PLL? Explain operation with basic blocks and mention four applications in radio communication.**
   - Appeared in: S25 (Q2b, 04 marks)
2. **Draw block diagram of PLL and briefly explain its operation.**
   - Appeared in: S23 (Q4b, 04 marks), S22 (Q3c, 07 marks)
3. **Design a monostable multivibrator for Tp = 11 ms, C = 0.01 µF.**
   - Appeared in: W25 (Q5a, 03 marks)
4. **Design a monostable multivibrator using timer IC for Tp = 11 ms, C = 0.1 µF.**
   - Appeared in: W22 (Q5a, 03 marks)
5. **Design an astable multivibrator using IC 555 for Ton = 50% of T, F=10 kHz, C=0.01 µF.**
   - Appeared in: W25 (Q5b, 04 marks)
6. **Design an astable multivibrator using IC 555 for Ton = 75% of T, F=1 kHz, C=0.1 µF.**
   - Appeared in: W22 (Q5b, 04 marks)
7. **Given R1=10KΩ, R2=50KΩ, C=0.01µF, calculate output frequency and duty cycle of 555 astable multivibrator.**
   - Appeared in: S23 (Q5a, 03 marks)
8. **Design an astable multivibrator with ~1 kHz using given components: resistors (2.2k, 3.9k, 4.7k), 0.1µF cap, IC555.**
   - Appeared in: W23 (Q1c, 07 marks)
9. **Explain applications of astable multivibrator using timer IC.**
   - Appeared in: W25 (Q5c, 07 marks)
10. **Write short note on voltage regulator.**
    - Appeared in: W25 (Q5b, 04 marks), W22 (Q5b, 04 marks), S23 (Q4a, 03 marks)
11. **What is a voltage regulator? List types.**
    - Appeared in: S23 (Q4a, 03 marks)
12. **Explain simple op-amp voltage regulator, three-terminal regulators (78XX, LM317), heat sink, dual power supply.**
    - From syllabus, asked indirectly in problems.
13. **Design an adjustable voltage regulator using LM317 for Vo=5–12V, Io=1A, Iadj=100µA, R1=240Ω.**
    - Appeared in: W23 (Q5c, 07 marks)
14. **Explain the design of LM317-based voltage regulator with example.**
    - Appeared in: W24 (Q5c, 07 marks)
15. **What are advantages of adjustable over fixed voltage regulators?**
    - Appeared in: S22 (Q3a OR, 03 marks)

Unit 6: Power Circuits and Systems

Repeated Questions:

1. **Explain class B power amplifier.**
    - Appeared in: W25 (Q3b, 04 marks), W22 (Q3b, 04 marks)
2. **Explain class A power amplifier.**
    - Appeared in: S23 (Q4a OR, 03 marks), S22 (Q5b, 04 marks)

Other Important Questions:

1. **Briefly explain class A power amplifier.**
    - Appeared in: S23 (Q4a OR, 03 marks)
2. **Draw and explain class AB power amplifier.**
    - Appeared in: W25 (Q4b, 04 marks), W22 (Q4b, 04 marks)
3. **Explain the working of class AB amplifier in brief.**
    - Appeared in: W23 (Q4b, 04 marks)
4. **Write short note on class-B push-pull power amplifier.**
    - Appeared in: S23 (Q4c OR, 07 marks)
5. **Write short note on transformer coupled audio power amplifier.**
    - Appeared in: S23 (Q5c, 07 marks)
6. **State at least one use of class A, class B, class C amplifiers.**
    - Appeared in: W24 (Q3a, 03 marks)
7. **Compare class A and class B amplifiers.**
    - Appeared in: W23 (Q3b, 04 marks)
8. **State main factors governing design of large signal (power) amplifiers.**
    - Appeared in: W24 (Q5a, 03 marks)

Unit 7: Active Filters

Repeated Questions:

1. **Analyze second-order Butterworth low-pass filter. Draw frequency response and state design procedure.**
    - Appeared in: S25 (Q3c OR, 07 marks), S22 (Q3c OR, 07 marks), W24 (Q4c, 07 marks)
2. **Analyze second-order Butterworth high-pass filter. Draw frequency response and state design procedure.**
    - Appeared in: S25 (Q3c, 07 marks)

Other Important Questions:

1. **Explain band-pass filter using op-amp.**
    - Appeared in: W25 (Q3b, 04 marks)
2. **Explain Sallen-Key second-order low-pass filter.**
    - Appeared in: S23 (Q5c, 07 marks), S22 (Q3c OR, 07 marks)
3. **Describe the process of designing a second-order active high-pass filter with example.**
    - Appeared in: W24 (Q4c, 07 marks)
4. **Design a second-order low-pass filter with Q=5, fc=159Hz, R=10KΩ.**
    - Appeared in: W23 (Q4c, 07 marks)
5. **Describe complete process of state-variable filter design in detail.**
    - Appeared in: W24 (Q4c, 07 marks), W23 (Q4c, 07 marks)
6. **Explain the importance of all-pass filter.**
    - Appeared in: S25 (Q3a OR, 03 marks)
7. **List disadvantages of active RC filters.**
    - Appeared in: W24 (Q3a, 03 marks)
8. **State applications of electronic filter circuits.**
    - Appeared in: W24 (Q5a, 03 marks)
9. **Give classification of types of filters with their responses.**
    - Appeared in: W24 (Q5b, 04 marks)
10. **What is an electronic filter? List all types.**
    - Appeared in: W23 (Q3a OR, 03 marks)
11. **Define: pass band, stop band, attenuation, cut-off frequency.**
    - Appeared in: S23 (Q5b, 04 marks)
12. **Explain difference between band-stop and band-pass filter.**
    - Appeared in: S23 (Q5a, 03 marks)
13. **How do active filters differ from passive filters?**
    - Appeared in: S23 (Q5b, 04 marks), S22 (Q4a OR, 03 marks)
14. **Explain absolute wave circuit.**
    - Appeared in: S25 (Q3b, 04 marks) *[Note: Likely "absolute value circuit"]*

Waveform Generators (Covered in Op-amp / Special ICs)

1. **Explain square wave generator using op-amp.**
    - Appeared in: S25 (Q3b OR, 04 marks), S22 (Q5c, 07 marks)
2. **Explain triangular wave generator using op-amp.**
    - Appeared in: S23 (Q3c, 04 marks), W22 (Q3c, 07 marks)
3. **Draw and explain sawtooth wave generator using op-amp.**
    - Appeared in: W25 (Q3c, 07 marks)
4. **Explain how op-amp can be used to generate free-running square wave.**
    - Appeared in: S25 (Q4c OR, 07 marks)

Miscellaneous / Cross-Unit

1. **Give full forms: CMRR, PSRR, PLL, ADC, HPF, VCO, ECL, VCVS, GBP**
    - Appeared in: W23 (Q2a, 03 marks), W23 (Q3a, 03 marks), W23 (Q5a, 03 marks)
2. **What is need of clipper circuit? Explain op-amp as positive and negative clipper.**
    - Appeared in: S25 (Q4c, 07 marks)

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