QuickNotes

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UGC NET Paper 2

Electronic Science (088)
Complete revision notes — all 10 units

10 units | Tables & formulas | Key revision points

01 Semiconductor Physics
02 Semiconductor Devices
03 Network Theory
04 Analog Circuits
05 Digital Electronics
06 Microprocessors and Microcontrollers
07 Signals and Systems
08 Communication Systems
09 Electromagnetics and Microwaves
10 Optoelectronics, Instrumentation and Control

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How to use these notes

- Read one unit at a time, then test yourself with its key revision points.
- Make your own short notes on topics you find difficult.
- Units follow the main areas of the official syllabus — the exact unit list can change between sessions.
- Always check the latest syllabus and notices on the official UGC NET portal: **ugcnet.nta.ac.in**.

UNIT 01

Semiconductor Physics

Energy bands, carriers and doping.

- Band gap: Si ≈ 1.12 eV, Ge ≈ 0.66 eV, GaAs ≈ 1.42 eV (at 300 K).
- Intrinsic vs extrinsic; n-type (donors — P, As), p-type (acceptors — B, Ga).
- Mass-action law: $n \cdot p = n_i^2$. Drift and diffusion currents; Einstein relation $D/\mu = kT/q$.
- Hall effect gives carrier type and concentration.

★ Key revision points

- Si band gap ≈ 1.12 eV.
- $n \cdot p = n_i^2$.
- Einstein relation: $D/\mu = kT/q$.
- Hall effect shows carrier type.

UNIT 02

Semiconductor Devices

Diodes, BJTs, FETs and special devices.

Device	Key fact
p-n diode	Shockley equation $I = I_0(e^{V/\eta V_T} - 1)$
Zener diode	Reverse breakdown; voltage regulator
BJT	$\beta = I_C/I_B$; $\alpha = \beta/(1+\beta)$
MOSFET	Voltage-controlled; enhancement and depletion types
Tunnel diode	Negative resistance region
SCR	Four-layer p-n-p-n switch

★ Key revision points

- $V_T \approx 26$ mV at room temperature.
- $\alpha = \beta/(1+\beta)$.
- Zener = voltage regulation.
- Tunnel diode shows negative resistance.

UNIT 03

Network Theory

Circuit laws and theorems.

- Kirchhoff's current and voltage laws; mesh and nodal analysis.
- Theorems: Thevenin, Norton, superposition, maximum power transfer ($R_L = R_{Th}$).
- Two-port parameters: z, y, h, ABCD. RLC resonance $f_0 = 1/(2\pi\sqrt{LC})$.

★ Key revision points

- Max power: $R_L = R_{Th}$.
- $f_0 = 1/(2\pi\sqrt{LC})$.
- h-parameters used for transistors.
- Superposition applies to linear circuits.

UNIT 04

Analog Circuits

Amplifiers, feedback, oscillators and op-amps.

- Negative feedback: stabilises gain, increases bandwidth. Barkhausen criterion: $A\beta = 1$ for oscillation.
- Oscillators: RC phase shift, Wien bridge, Hartley, Colpitts, crystal.
- Ideal op-amp: infinite gain and input impedance, zero output impedance. Inverting gain = $-R_f/R_{in}$; non-inverting = $1 + R_f/R_{in}$.

★ Key revision points

- Barkhausen: $A\beta = 1$.
- Inverting gain = $-R_f/R_{in}$.
- Negative feedback raises bandwidth.
- Crystal oscillator is most stable.

UNIT 05

Digital Electronics

Logic, combinational and sequential circuits.

- Universal gates: NAND, NOR. De Morgan's theorems; K-maps.
- Combinational: adders, multiplexers, decoders. Sequential: SR, JK, D, T flip-flops; counters; shift registers.
- Logic families: TTL, CMOS (lowest power), ECL (fastest).

★ Key revision points

- NAND and NOR are universal.
- CMOS = lowest power.
- ECL = fastest.
- JK flip-flop toggles when J = K = 1.

UNIT 06

Microprocessors and Microcontrollers

8085, 8086 and 8051 basics.

Chip	Key facts
8085	8-bit; 16-bit address bus (64 KB); 5 hardware interrupts (TRAP non-maskable)
8086	16-bit; 20-bit address bus (1 MB); segmented memory
8051	8-bit microcontroller; 4 KB ROM, 128 B RAM, 4 I/O ports, 2 timers

★ Key revision points

- 8085 addresses 64 KB.
- 8086 addresses 1 MB.
- TRAP is non-maskable.
- 8051 has 4 I/O ports.

UNIT 07

Signals and Systems

Transforms and sampling.

- Fourier series and transform; Laplace transform; Z-transform for discrete systems.
- Nyquist sampling theorem: $f_s \geqslant 2f_{max}$.
- LTI systems: convolution; stability (poles in left half s-plane / inside unit circle).

★ Key revision points

- Nyquist: $f_s \geqslant 2f_{max}$.
- Z-transform for discrete signals.
- Stable: poles in left half-plane.
- LTI output = input * impulse response.

UNIT 08

Communication Systems

Analog and digital modulation.

- AM: modulation index; bandwidth = $2f_m$. FM: Carson's rule BW = $2(\Delta f + f_m)$.
- Digital: PCM, ASK, FSK, PSK, QAM. Shannon capacity $C = B \log_2(1 + S/N)$.
- Multiplexing: FDM, TDM, CDMA.

★ Key revision points

- AM bandwidth = $2f_m$.
- Carson's rule for FM.
- Shannon: $C = B \log_2(1+S/N)$.
- QAM varies amplitude and phase.

UNIT 09

Electromagnetics and Microwaves

Maxwell's equations, waveguides and antennas.

- Maxwell's equations; Poynting vector; skin depth.
- Transmission lines: VSWR, reflection coefficient; Smith chart.
- Microwave devices: klystron, magnetron, TWT, Gunn diode. Antennas: dipole, Yagi, parabolic.

★ Key revision points

- VSWR = 1 means matched line.
- Magnetron used in radar and ovens.
- Gunn diode = transferred electron device.
- Poynting vector = power flow.

UNIT 10

Optoelectronics, Instrumentation and Control

Optical devices, measurement and control systems.

- LED, laser diode, photodiode, solar cell; optical fibre (total internal reflection).
- Transducers: thermocouple, strain gauge, LVDT; CRO.
- Control: transfer function, Routh–Hurwitz, Bode plot, Nyquist criterion; PID controller.

★ Key revision points

- Optical fibre: total internal reflection.
- LVDT measures displacement.
- Routh–Hurwitz tests stability.
- PID = proportional, integral, derivative.

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