G 7035 (Pages : 2) Reg. No.....

Name.....

B.TECH. DEGREE EXAMINATION, APRIL 2011

Eighth Semester

Branch : Electrical and Electronics Engineering

ELECTRICAL SYSTEM DESIGN (E)

(Regular/Supplementary)

Time : Three Hours Maximum : 100 Marks

Part A

Answer **all** *questions.*

Each question carries 4 *marks.*

1. Find the minimum number of poles for a 1200 kW generator if the average voltage between commutator segments is not to exceed 15 and armature movement per pole is not to exceed 10000 A.
2. Briefly explain the factors to be considered in the design of insulation in transformers.
3. Explain the factors to be considered in the choice of armature winding in a DC machine.
4. What is window space factor ? Find the width of window for optimum output of a transformance.
5. Comment on size and shape of rotor bars in Induction motors.
6. What are the factors to be considered to select the specific electric loading of synchronous generator ?
7. Explain why it is necessary to provide earthing in a domestic electric installation ?
8. State reasons why the load in a consumers installation is divided into sub circuits ?
9. Write short notes on earth mat.
10. Discuss the factors affecting the sag.

(10 × 4 = 40 marks)

Part B

Each question carries 12 *marks.*

11. A 500 kW, 460 V, 8 pole, 375 r.p.m. compound generator has an armature diameter of 1.1 m and a core length of 0.33 m. Design a symmetrical armature winding giving the details of equalizers. The ampere conductors per meter are 34000. The internal voltage drop is 4 per cent of terminal voltage and the filed current is 1 per cent of output current. The ratio of pole arc to pole pitch is 0.7. The voltage between adjacent segments at no load should not exceed 15 V and the slot loading should not exceed 1500 A. The diameter of commutator is 0.65 of armature diameter and the minimum allowable pitch of segments is 4 mm.

Or

12. The following particulars refer to the shunt field coil for a 440 V, 6 pole, d.c. generator : Mmf per pole = 7000 A ; depth of winding = 50 mm ; length of inner turn = 1.1 m ; length of outer turn = 1.4 m ; loss radiated from outer surface excluding ends = 1400 W/m^2 ; space factor = 0.62. resistivity = $0.02\Omega/m$ and mm^2 . Calculate (a) diameter of wire ; (b) length of coil ; (c) number of turns and (d) exciting current. Assume a voltage drop of 20 per cent of terminal voltage across the field regulator.

13. Determine the main dimensions of the core, the number of turns and the cross-section of the conductors for a 5 kVA, 11000/400 V, 50 Hz, single phase core type distribution transformer. The net conductor area in the window is 0.6 times the net cross–section of iron in the core. Assume a square cross-section for the core, a flux density $1Wb/m^2$, a current density $1.4A/mm^2$ and a window space factor 0.2. The height of window is 3 times its width.

Or

14. Explain the design procedure of a single phase 230V/6V transformer.

15. A 1000 kVA, 3300 V, 50 Hz, 300 r.p.m., 3 phase alternator has 180 slots with 5 conductors per slot. Single layer winding with full pitch coils is used. The winding is star connected with one circuit per phase. Determine the specific electric and specific magnetic loadings if the stator bore is 2m and the core length is 0.4 m. Using the same loadings, determine the corresponding data for a 1250 kVA, 3300 V, 50 Hz, 250 r.p.m., 3 phase star connected alternator having 2 circuits per phase. The machines have 60° phase spread.

Or

16. Explain about different points while designing a rotor in the 3 pahse Induction motors.

17. Draw the electric circuit and estimate the quantity of material and total cost for casing - capping wiring system used in a hall of 15 m × 6 m × 4 ½ m height. The hall is to be fitted with fan points and light points. Make your own assumptions for the number of fan and light points and other missing data.

Or

18. Design the electrical system of a Cinema theatre measuring 36 m × 27 m with a seating capacity of 600 persons and receives supply at 400 volts, 3ϕ, 50 Hz.

19. Estimate the main material requirement for a 2 km, 11 kV overhead line having a span between two poles of 45 m. Dead-end poles and every 10^{th} structure is to be a double pole to facilitate sectionalising, sagging and stringing. The conductor used is ACSR conductor $6/1 \times 2.11 mm$.

Or

20. Estimate the material requirement for the installation of a 400 kVA, 11kV/415 V foundation mounted out door substation.

(5 × 12 = 60 marks)

G 7057 (Pages : 2) Reg. No.....

Name.....

B.TECH. DEGREE EXAMINATION, APRIL 2011

Eighth Semester

Branch : Electrical and Electronics Engineering

ADVANCED POWER SYSTEMS (Elective II) (E)

(Regular/Supplementary)

Time : Three Hours Maximum : 100 Marks

Part A

1. Explain turbine-speed governing system.
2. Explain how control area concept is implemented for generators and loads.
3. Explain fuel scheduling.
4. Briefly explain various constraints in the operation of a thermal plant.
5. What do you mean by short range hydro scheduling ?
6. Explain a method to save fuel cost at peak load.
7. Explain the advantage of centrally dispatched power pools.
8. Write short note on interchange evaluation with unit commitment.
9. Explain AC powerflow in security analysis.
10. Explain the term line outage distribution factor.

(10 × 4 = 40 marks)

Part B

Each question carries 12 *marks.*

11. Explain the model of speed governing system. (12 marks)

Or

12. (a) Explain the objectives of AGC. (4 marks)

(b) Two generators rated 200 MW and 400 MW are operating in parallel. The droop characteristics of their governors are 4% and 5% respectively from no load to full load. Assuming that the generators are operating at 50 Hz at no load, how would a load of 60 MW be shared between them. What will be the system frequency at this load ? Assume free governor operation. Repeat the problem of both governors have a droop of 4%.

(8 marks)

Turn over

13. Explain direct programming method for solving unit commitment problem.

Or

14. Explain the priority list method for solving unit commitment solution methods. (12 marks)

15. Obtain Lagrange function for 3 hydraulically coupled hydroelectric plants.

Or

16. Explain the short-term hydrothermal scheduling problem with hydraulic constraints. (12 marks)

17. Explain the different types of power interchange for economic aspects. (12 marks)

Or

18. (a) Explain power pools. (4 marks)

    (b) Mention the advantages and disadvantages of power pools. (4 marks)

    (c) What is energy broker system ? (4 marks)

19. Explain the contingency analysis technique used in network problems.

Or

20. Explain power system security considering the major security functions involved with some examples. (12 marks)

(5 × 12 = 60 marks)

G 7058 (Pages : 2) Reg. No.....

Name.....

B.TECH. DEGREE EXAMINATION, APRIL 2011

Eighth Semester

Branch : Electrical and Electronics Engineering

ADVANCED MICROPROCESSORS—(Elective II) (E)

(Regular/Supplementary)

Time : Three Hours Maximum : 100 Marks

Part A

Answer all *questions.*

Each question carries 4 *marks.*

1. Explain the registers in 8086.
2. Interrupts are powerful concepts. Explain.
3. Differentiate between jmp and call instructions.
4. Write notes on memory banks and bank decoders.
5. Discuss the interaction between 8086 and 8087.
6. Explain what is memory paging. How is it useful ?
7. Explain the features of 80286 processor.
8. What are descriptors and selectors ?
9. Compare and contrast RISC and CISC processors.
10. Discuss hyper pipelined technology.

(10 × 4 = 40 marks)

Part B

Each question carries 12 *marks.*

11. Write notes on (i) pipelining (ii) maximum and minimum modes of operation of 8086.

Or

12. Explain the need for bus buffering and latching with schematics show they are implemented.
13. Explain with examples, the data addressing modes of 8086.

Or

Turn over

14. Write an assembly language program to copy a block of 10 bytes in memory from one location to another.

15. Discuss the architectural features of 80286 in detail.

Or

16. (i) Discuss the data types handled by 8087.

(ii) Write notes on 80186 processor.

17. Explain the memory and I/O systems in 80386.

Or

18. (i) Explain what is protected mode of operation.

(ii) What is Cache memory ? Explain.

19. Write notes on P II and P III processors.

Or

20. Discuss Pentium memory management.

(5 × 12 = 60 marks)

G 7008 (Pages : 3) Reg. No.....

Name.....

B.TECH. DEGREE EXAMINATION, APRIL 2011

Eighth Semester

Branch : Electrical and Electronics Engineering

E 801—POWER SYSTEM ANALYSIS (E)

(Regular/Supplementary)

Time : Three Hours Maximum : 100 Marks

Part A

Answer **all** *questions.*
Each question carries 4 *marks.*

1. Draw the impedance diagram of power system have generators, transformers and load.
2. Explain the term sequence networks.
3. Obtain equations for real power and reactive power used in load flow problem.
4. Explain regulating transformer for voltage control.
5. Explain automatic load dispatching.
6. Explain co-ordination equations for solving optimal load dispatch.
7. Explain different types of faults in power system.
8. Explain how a circuit breaker is selected for fault conditions in power system.
9. Explain the major factors affecting transient stability.
10. Define inertia constant.

(10 × 4 = 40 marks)

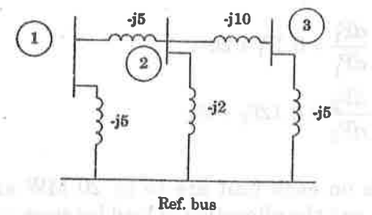
Part B

Answer **all** *questions.*
Each question carries 12 *marks.*

11. The line to ground voltages on the high voltage side of a step-up transformer are 100 kV, 33 kV and 38 kV on phases *a*, *b* and *c* respectively. The voltage of phase a leads that of phase *b* by 100° and lags that of phase *c* by 176.5°. Determine analytically the symmetrical components of voltage.

Or

12. For the system shown below, determine Z_{bus}.



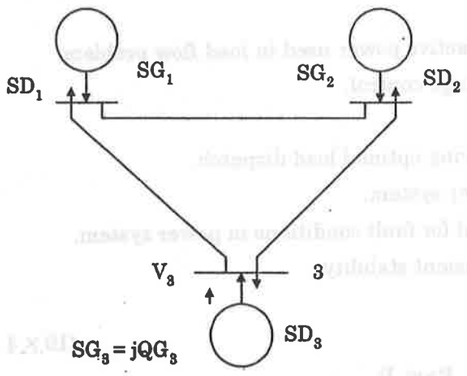
Turn over

13. Explain G-S algorithm for load flow solution when PV buses are also present.

Or

14. Consider the three bus system shown below. Each of the three lines has a series impedance of $0.02 + j\ 0.08$ p.u. and a total shunt admittance fo $j\ 0.02$ pu. The specified quantities at the buses are tabulated below :

Bus	Real load demand P_D	Reactive load QD	Real power generation PG	Reactive power generation QG	Voltage specification
1	2.0	1.0	unspecified	unspecified	$V_1 = 1.04 + jo$ (slack bus)
2	0.0	0.0	0.5	1.0	unspecified (PQ bus)
3	1.5	0.6	0.0	QGS = ?	$V_B = 1.04$ (PV bus)



$SG_1 = PG_1 + jQG_1$

$SD_1 = PD_1 + jQD_1 = 2.0 + j1.0$

$SG_2 = PG_2 + jQG_2 = 0.5 + j\ 1.0$

$SD_2 = PD_2 + j\ QD_2 = 0.0 + 0.0$

Controllable reactive power source is available at bus 3 with constraint, $0 \le QG_3 \le 1.5$ pu. Find the load flow solution using the NR method. Use a tolerance of 0.01 for power mismatch.

(12 marks)

15. Derive the transmission loss formula considering the B coefficients.

Or

16. Incremental fuel costs in Rs. per megawatt hour for two units in a plant are :

$$\frac{dF_1}{dP_1} = 0.1P_1 + 20$$

$$\frac{dF_2}{dP_2} = 0.12P_2 + 16.$$

The minimum and maximum loads on each unit are to be 20 MW and 125 MW respectively. Determine the incremental fuel cost and the allocation of load between units for the minimum cost when loads are (i) 100 MW ; (ii) 150 MW. Assume both units are operating.

17. A small generating station has a busbar divided into three sections. Each section is connected to a tiebar with reactors each rated at 5 MVA, 0.1 pu, reactance. A generator of 8 MVA rating and 0.15 pu reactance is connected to each section of the busbar. Determine the short circuit capacity of the breaker if a 3-phase fault takes place on one of the sections of the busbar.

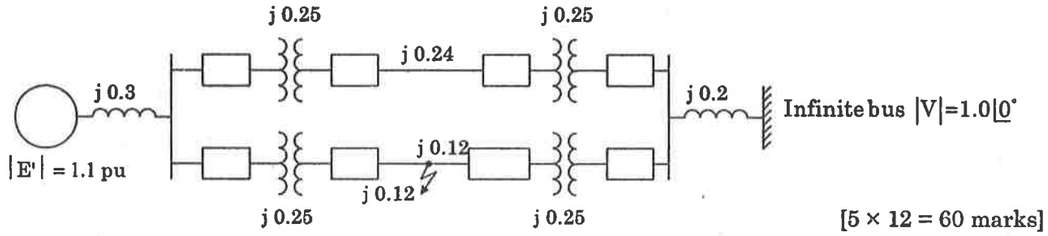
Or

18. Draw a diagram showing interconnection of sequence network for a single line to ground fault. Derive the equations for sequence currents.

19. Derive the equation for equal area criterion using the swing equation for a machine connected to infinite bus.

Or

20. Find the critical clearing angle for the system shown in figure for a 3-phase fault at the point F. The generator in delivering 1.0 pu power under prefault conditions.



[5 × 12 = 60 marks]

G 7015 (Pages : 2) Reg. No.....

Name.....

B.TECH. DEGREE EXAMINATION, APRIL 2011

Eighth Semester

Branch : Electrical and Electronics Engineering

E 802—SWITCHGEAR PROTECTION (E)

(Regular/Supplementary)

Time : Three Hours Maximum : 100 Marks

Part A

Answer **all** *the questions.*

Each question carries 4 *marks.*

1. Explain current chopping in *h v* systems.
2. Explain the characteristic features of vacuum CB.
3. Explain the basic requirements of a protective relaying.
4. Explain the negative Phase - sequence relay used in protection scheme.
5. All 11 KV, 100 MVA, alternator is provided with differential protection. The percentage of winding to be protected against phase to ground fault is 83%. The relay is set to operate when there is 20% out of balance current. Determine the value of the resistance to be placed in the neutral to ground protection.
6. Explain over-current protection scheme for transformers.
7. Explain time graded protection scheme for radial feeders.
8. Explain time distance and definite distance protection schemes used for transmission lines.
9. Explain counter-poise arrangement of earth wires.
10. Explain reflection refraction of travelling waves through transmission lines.

(10 × 4 = 40 marks)

Part B

Each question carries 12 *marks.*

11. Explain SF_6 CB using a neat figure and write the advantages of SF_6 CB. Write the important features of SF_6 gas.

(12 marks)

Or

12. (a) Explain arc Phenomenon. (6 marks)

(b) How the arc is interrupted in hv systems. (6 marks)

13. (a) Explain static overcurrent relay using block diagram and give the definite time and inverse time characteristics. (8 marks)

(b) Explain IDMT relay. (4 marks)

Or

14. Give the constructional features and principle of operation and characteristics of static directional relay. (12 marks)

15. Explain biased differential protection scheme for power transformers. (12 marks)

Or

16. Explain the circulating current protection schemes for generators. (12 marks)

17. Explain using wave forms and block diagram carrier current Protection scheme for generators. (12 marks)

Or

18. Explain the Merz - Price protection scheme for feeder protection. (6 marks)

19. With neat sketches explain surge diverter and thyrite arrester. (6 marks)

Or

20. Using mathematical model explain propagation of surges in transmission lines. Ignore the line losses. (12 marks)

[5 × 12 = 60 marks]

G 7026 (Pages : 2) Reg. No.....

Name.....

B.TECH. DEGREE EXAMINATION, APRIL 2011

Eighth Semester

Branch : Electrical and Electronics Engineering

INSTRUMENTATION (E)

(Regular/Supplementary)

Time : Three Hours Maximum : 100 Marks

Part A

Answer **all** *questions.*
Each question carries 4 *marks.*

1. Differentiate between Static and Dynamic characteristics.
2. Define transducers. What are the classifications of transducers ?
3. Explain principle of operation of a piezoelectric transducer with its materials for construction.
4. Explain any *two* types of capacitive transducer with their application.
5. Explain the laws of thermocouple.
6. Briefly explain the characteristics of thermistors.
7. Explain any one type of optical transducer with its applications.
8. What is meant by absolute acceleration ? Explain with diagram the null balance type accelerometer.
9. Draw the block diagram of a spectrum analyzer and explain with its applications.
10. Explain the working principle of an ionization gauge.

(10 × 4 = 40 marks)

Part B

Answer **all** *questions.*
Each question carries 12 *marks.*

11. Draw the generalised input, output configuration of measurement systems and explain in detail with examples.

(12 marks)

Or

12. (a) What is meant by loading ? Explain in detail the loading effect due to series and shunt connected devices. Comment on them.

(8 marks)

(b) Draw the circuit of an isolation amplifier and explain with its application. (4 marks)

Turn over

13. (a) Explain the working principle of a resistance potentiometer and explain how it can be used for measuring displacement. Also explain the "loading effect" on the accuracy of a resistance-potentiometer transducer when used for measurement of displacements. (8 marks)

(b) What are load cells ? What are its applications ? (4 marks)

Or

14. (a) Explain the working principle of a LVDT with its circuitry and explain how it can be used for measuring displacements. What are its advantages and disadvantages ? (6 marks)

(b) Explain the temperature effects on strain gauges and how it is compensated. (6 marks)

15. Explain in detail different types of pyrometers with diagram. What are their applications ? (12 marks)

Or

16. (a) Explain the principle of operation of a RTD with its bridge circuits in detail. (8 marks)

(b) Draw any one type of thermoelectric circuit using thermocouple and explain. (4 marks)

17. Explain with diagram the electromagnetic and ultrasonic flowmeters. Compare their performances.

Or

18. Describe the ultrasonic flow detectors with diagram. Compare them. (12 marks)

19. (a) Explain with figure the working of a hygrometer. What are its applications ? (6 marks)

(b) Draw the block diagram of a scintillation counter and explain. (6 marks)

Or

20. (a) Explain with block diagram the wave analyzer. (6 marks)

(b) What is pH ? Explain how pH is measured. What are the precautions to be taken ? (6 marks)

[5 × 12 = 60 marks]

G 7060 (Pages : 2) Reg. No.....

Name.....

B.TECH. DEGREE EXAMINATION, APRIL 2011

Eighth Semester

Branch : Electrical and Electronics Engineering

ADVANCED POWER ELECTRONIC SYSTEMS—(Elective II) (E)

(Regular/Supplementary)

Time : Three Hours Maximum : 100 Marks

Part A

Answer **all** *questions.*

Each question carries 4 *marks.*

1. Explain the various DC-DC converter topologies.
2. Discuss the PWM method of control of DC-DC Converters.
3. With a neat circuit diagrams explain the push pull topology of SMPS.
4. Draw the block diagram of current mode control of SMPS.
5. List the advantages of Resonant converters.
6. Discuss the principle of zero current switching of resonant converters.
7. What are the various PWM techniques ?
8. What are the current mode control schemes for PWM Inverters ? Explain.
9. Define displacement factor and distortions factor.
10. Draw the block schematic diagram of an electronic ballast.

(10 × 4 = 40 marks)

Part B

Each question carries 12 *marks.*

11. Explain the operation of the basic Cuk Converter. What are its main advantages ? Obtain the relation between input and output voltage of this converter

Or

12. In a back-boost regulator the following parameters are given (i) input voltage = 24 V, (ii) Operating frequency = 20 kHz, (iii) The Inductance = 200 μH , (iv) Capacitor = 500 μH (v) average load current = 5 A, (vi) duty ratios are (a) 0.2 and (b) 0.7. Find the average output voltage, peak to - peak inductor ripple current, peak to peak output ripple voltage, and the average Input Current (assume circuit is loss free).

Turn over

13. With a block Schematic diagram explain the operation of an SMPS. Discuss its advantages and disadvantages.

Or

14. (i) List the industrial applications of SMPS. Compare the performance of switched mode power supply and a linear power supply.

(ii) Explain the principle of a fly back converter.

15. Draw the circuit diagram of a half bridge resonant inverter and explain its operations. What is the difference between half bridge and full bridge.

Or

16. What do you understand by zero voltage and zero current switching ? What is the difference between 2VS and 2 CS ? What is the main advantage of zero current switching ?

17. With necessary waveforms explain the principle of sinusoidal PWM. Explain its application to single-phase bridges.

Or

18. (i) Compare bipolar and unipolar PWM Switching Schemes.

(ii) With a neat block diagram describe the tolerance band control of PWM inverters.

19. Explain the principle of power factor correction. Describe the input line current shaping using boost rectifiers.

Or

20. (i) Draw the block schematic of a UPS and explain.

(ii) Discuss the advantages and applications of UPS.

(5 × 12 = 60 marks)

G 7089 (Pages : 2) Reg. No.....

Name.....

B.TECH. DEGREE EXAMINATION, APRIL 2011

Eighth Semester

Branch : Electrical and Electronics Engineering

DIGITAL PROTECTION OF POWER SYSTEMS (Elective III) (E)

(Regular/Supplementary)

Time : Three Hours Maximum : 100 Marks

Part A

Answer **all** *questions.*

Each question carries 4 *marks.*

1. Discuss the consequences of fault in power system.
2. What are various methods of providing back up protection.
3. Distinguish between stack point and program counter.
4. Describe the status flags of intel 8085 microprocessor.
5. Describe the realization of a directional impedance relay using microprocessor.
6. Describe the realization of restricted mho relay.
7. What are the functions of sample and hold circuits?
8. How can R and X of the line up to the fault point be calculated by an algorithm based on RHT?
9. What do you mean by FWHT?
10. Why is half cycle data window preferred over the full cycle data window for digital distance relaying.

(10 × 4 = 40 marks)

Part B

Answer **all** *questions.*

Each question carries 12 *marks.*

11. Discuss the different types of PT's with their area of application. (12 marks)

Or

12. Discuss what do you understand by selectivity and stability of a protective relay. Discuss the essential qualities of a protective relay. (12 marks)

Turn over

13. What is a semiconductor memory? Discuss different types of semiconductor memories. (12 marks)

Or

14. What is a single chip microcomputer? Describe the latest 8 bit single chip microcomputer. (12 marks)

15. Explain offline application of computer. (12 marks)

Or

16. Explain the importance of relay co-ordination programme. (12 marks)

17. Explain Quadrilateral relay in detail. (12 marks)

Or

18. How alternators are protected against loss of excitation. (12 marks)

19. Draw the block diagram of a microprocessor based over current relay and explain the same in detail. (12 marks)

Or

20. Draw the programme flow chart of a microprocessor based over current relay. (12 marks)

[5 × 12 = 60 marks]

G 7090 (Pages : 2) Reg. No.....

Name.....

B.TECH. DEGREE EXAMINATION, APRIL 2011

Eighth Semester

Branch : Electrical and Electronics Engineering

INSULATION TECHNOLOGY (Elective III) (E)

(Regular/Supplementary)

Time : Three Hours Maximum : 100 Marks

Part A

Answer **all** *questions.*

Each question carries 4 *marks.*

1. What are electronegative gases ? Discuss their properties and applications.
2. Explain the temperature classification of insulating materials.
3. Discuss one method for measurement of dissipation factor.
4. Explain the factors influencing permittivity.
5. Discuss dipole moment and polarization.
6. What are the causes of surges in HV systems ?
7. Explain ionization by collision.
8. Define time lag for breakdown.
9. What is corona discharge ? Explain Anode corona and Cathode corona.
10. Why thermal breakdown in more significant in solid dielectrics compared to other b.d. mechanisms ?

(10 × 4 = 40 marks)

Part B

Each question carries 12 *marks.*

11. Explain the properties of various insulating materials for use in :
    (a) Cables.
    (b) Line insulators.

Or

12. Explain the preparation and properties of :

(a) Paper.

(b) Epoxy resin.

(c) Transformer oil.

13. Discuss the methods for measurement of resistivity.

Or

14. Explain the method for detection and measurement of partial discharges.

15. Discuss the concept of internal field and derive the Clausius Mosotti equation.

Or

16. Explain Electronic and Interfacial Polarization in dielectrics.

17. Explain Townsend's Criteria for spark and obtain Townsend's first and second ionisation coefficients.

Or

18. Explain the following : —

(a) Paschen's Law.

(b) Penning effect.

(c) Breakdown in electronegative gases.

19. Explain the various mechanisms of breakdown in commercial liquids.

Or

20. Write short notes on the following : —

(a) Electromechanical breakdown.

(b) Intrinsic breakdown.

(c) Breakdown of composite dielectrics.

[5 × 12 = 60 marks]

G 7093 (Pages : 2) Reg. No.....

Name.....

B.TECH. DEGREE EXAMINATION, APRIL 2011

Eighth Semester

Branch : Electrical and Electronics Engineering

VLSI TECHNOLOGY (Elective III) (E)

(Regular/Supplementary)

Time : Three Hours Maximum : 100 Marks

Answer **all** *questions.*

Part A

1. Explain about silicon shaping.
2. Explain about reactors and metallisation.
3. Briefly explain about sub threshold conduction junction leakage.
4. Explain about circuit extractors.
5. Explain lambda based design rules.
6. Design a two input BiCMOS NAND gate and explain its operation.
7. Briefly explain about Double rail logic, Non-restored logic.
8. Draw a DC transfer characteristics of CMOS inverter.
9. Compare CMOS and GaAS technologies.
10. Explain doping process in GaAS technology.

(10 × 4 = 40 marks)

Part B

11. Explain the following :
    (a) Complementary error functions.
    (b) Fin line lithography.
    (c) Oxidation process.

(3 × 4 = 12 marks)

Or

12. Explain about patterning and wire bonding.

(12 marks)

Turn over

13. How Schottsky diodes are fabricated in IC form? Explain.

Or

14. Explain the fabrication of MOS resistors and capacitors.

15. Explain the CMOS fabrication of n-well process with neat diagrams.

Or

16. Explain about scaling of MOS structures.

17. Explain in detail the static and dynamic power dissipations. How they can be reduced?

Or

18. Draw and explain the operation of (a) CMOS inverter ; (b) Pseudo NMOS inverter ; (iii) Dynamic inverter.

19. Explain sub-micro CMOS technology.

Or

20. Explain the planar process flow of depletion mode MESFET with neat diagram.

(5 × 12 = 60 marks)