Khulna University of Engineering & Technology
B. Sc. Engineering 4th Year 2nd Term (Regular) Examination, 2017
Department of Electrical and Electronic Engineering
EE 4203
Switchgear and Protection

Time: 3 hours Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.
(ii) Figures in the right margin indicate full marks.

Section A

Q1. (a) What do you mean by switchgear and switchyard? Explain the significance of load break switch in power system. (08)

(b) Define interlocking. Explain the interlocking arrangement of circuit breaker, isolator and earthing switch during maintenance of transmission line. (09)

(c) Explain the effect of natural frequency and power factor on recovery voltage. (08)

(d) Discuss the problems that might arise during switching of a capacitor bank. Use necessary diagram in the illustration. (10)

Q2. (a) Explain Cassie's theory for arc interruption with assumption. Mention the limitation of Slepian's theory for arc interruption. (12)

(b) Explain the operation and significance of auto-reclosure in power system protection. (08)

(c) Point out the technical particulars of a circuit breaker. (06)

(d) In a short circuit test on a 132 kV, 3-phase system, the data got from the breaker: pf of the fault is 0.45, recovery voltage is 0.95 times the full line voltage, breaker current is symmetrical and restriking transient had natural frequency of 16 Hz. Determine the average RRRV. Assume the fault is grounded. (09)

Q3. (a) Explain the operation of oil circuit breaker with relevant advantages and disadvantages. Also write down the maintenance schedule of OCB. (12)

(b) Explain how arc is formed in CB. Describe the high resistance arc interruption method clearly. (11)

(c) Deduce the expression for ordinary fuse law. The melting point of lead fuse is 624°F. What will be the temperature of the fuse when 5/6 of the fusing current passes through it? The room temperature is 55°F. (12)

Q4. (a) Mention the factors to be considered for selection of bus layout. Explain equipment earthing and neutral earthing. (12)

(b) Explain different types of test conducted on a circuit breaker. (08)

(c) What is meant by over current relay co-ordination? Using standard IDMT relays, calculate the relay settings of R_1, R_2 and R_3 for the following system. PSM and TSM of relay R_4 is 100% of CT secondary rating and 0.1, respectively. (15)

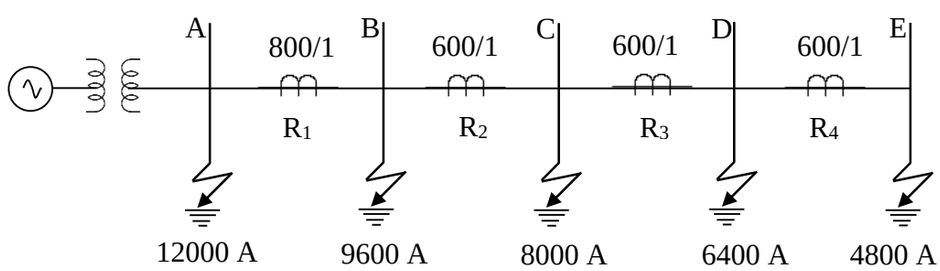

Fig. for Q4(c).

Section B

Q5. (a) What is protective relaying? Write down the desirable qualities of protective relaying. (09)

(b) Describe the phase comparison of carrier current protection. Explain why a 90° connection is used in case of directional relay for phase fault protection. (12)

(c) Describe the construction and principle of operation of a double actuating quantity relay based on attracted principle. Justify the disc of relay made by Al. (14)

Q6. (a) What is biased coil? Why it is used in differential protection? With the help of neat sketch explain the biased differential protection of a Y/Δ power transformer. (14)

(b) "Neutral earthing plays a vital role in earth fault protection" – Justify the statement. (07)

(c) A 200 kV long X-mission line has an impedance of (2+j8) Ω. Suggest suitable distance relays for its protection and determine the setting of the relays for all the zones given that (14)

(i) Zone-I covers 80% of the line length

(ii) Zone-II covers 150% of the line length

(iii) Zone-III covers 225% of the line length

Assume a fault resistance of 2 Ω while deciding setting and a suitable characteristics angle of the distance relay suggested by you. Given that CT ratio = 1000/1 A and PT ratio = 220 kV/110 V.

Q7. (a) What is lightning? What are the requirements of a good lightning arrestor? (09)

(b) What is meant by 3-zone protection? Explain such scheme for the transmission line protection. (12)

(c) Draw a detailed protective scheme for biased differential protection of an 11/132 kV, 150 MVA, DY-I power transformer. Suggest a suitable CT ratio. Also suggest the proper ICT for the scheme. (14)

Q8. (a) Describe the constructional features and operating principle of a negative phase sequence relay. (10)

(b) What is restricted earth fault protection for alternator? Explain. (08)

(c) Explain the inter turn fault protection. (06)

(d) An 11 kV, 25 MVA star connected alternator has a reactance of 1.5 Ω/phase and negligible resistance. Differential protection scheme is used which operates when the out of balance current exceeds 25% of the full load current. The neutral of the generator is grounded through a resistance of 8 Ω. Determine the portion of the winding which remain unprotected against earth fault. What will be the value of resistance if 10% winding is unprotected. (11)

Khulna University of Engineering & Technology

B. Sc. Engineering 4th year 2nd Term (Regular) Examination, 2017

Department of Electrical and Electronic Engineering

EE 4205

RADAR, Satellite and Optical Communication

Time: 3 hours Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.
(ii) Figures in the right margin indicate full marks.

Section A

Q1. (a) What is optical fiber? Mention the important reasons for which we would consider optical fiber instead of copper cable. (07)

(b) Describe the loss mechanisms in silica optical fiber using necessary illustrations. (12)

(c) Briefly illustrate different ray propagation techniques in fiber-optic waveguide. (05)

(d) A typical relative refractive index difference for an optical fiber designed for long distance transmission is 1.5%. Estimate the NA and the solid acceptance angle for the fiber when the core index is 1.5. Further, calculate the critical angle at the core-cladding interface within the fiber. Assume that the concepts of geometric optics hold for the fiber. (11)

Q2. (a) Starting with Maxwell's equations, derive the eigenvalue equation by matching the boundary conditions at the core-cladding interface of a step-index fiber. (14)

(b) What are the dispersion mechanisms found in fiber optic waveguide? Derive the mathematical relation of modal dispersion. How such dispersion severely degrades system performance? (11)

(c) A glass fiber exhibits material dispersion given by $\left|\lambda^2 (d^2 n_1)/d\lambda^2\right|$ of 0.025. Determine the material dispersion parameter at a wavelength of 1550 nm, and estimate the rms pulse broadening per kilometre for a good LED source with an rms spectral width of 20 nm at this wavelength. (10)

Q3. (a) What are different fiber joints? What are the important factors to be considered for making such joints? Show different types of fiber misalignments with necessary diagrams. (09)

(b) Classify different fiber couplers. What is GRIN-rod lens? Describe its application in fiber optic communication. (08)

(c) Define the terms: responsivity, quantum efficiency, and absorption coefficient. (09)

(d) An InGaAsP LED, with a bandgap of 1.5×10^{-19} J, is used as the transmitter for an optical system. The LED has a total quantum efficiency (given by the product of internal and external quantum efficiencies) of 0.1. The diode current is 30 mA. (i) Estimate the wavelength of the optical output and (ii) Find the optical output power. (09)

Q4. (a) Define population inversion condition in a laser medium. Draw the basic structure of a laser and then explain the operation of DFB laser. (10)

(b) What is photo detector? Classify it. Show that the responsivity of APD is $R = \frac{M\eta e\lambda}{hc}$, where the symbols have their usual meanings. (10)

(c) Draw the basic structure of an optical receiver. What are the sources of noise in an optical receiver? (05)

(d) What is the nonlinear effect in optional fiber? Briefly explain the self phase modulation (SPM) and four wave mixing (FWM) phenomena in fiber. (10)

Section B

Q5. (a) Describe the evolution and growth of communication satellites. (08)

(b) What are the advantages and disadvantages of satellite communication? (06)

(c) Explain the terms: (i) Faraday's effect, (ii) EIRP, (iii) Apogee, and (iv) Perigee. (10)

(d) Show that the complete link design depends on the quality of downlink. (11)

Q6. (a) Why is satellite launched above 1500 km? Describe the various communication satellite orbits. (12)

(b) Draw and explain the block diagram of a conventional repeater. Also draw the block diagram of RF front end and different carrier processing. (14)

(c) A satellite located at 40,000 km from earth operates at a frequency of 6 GHz and has EIRP of 21 dBW. If the receiving antenna has a gain of 50.5 dB, find the received power. (09)

Q7. (a) What are the design requirements of an earth station? Draw the block diagram of an earth station and explain the functions of each block in brief. (12)

(b) What is Radar? Deduce the range equation of Radar. Discuss on the factors that influence the maximum range of Radar. (14)

(c) What are diplexer and duplexer? Write down short notes on TR-ATR tubes? (09)

Q8. (a) Draw the block diagram of MTI radar system and explain the functions of each block in brief. (12)

(b) What is CW Radar? How does it work? Mention some advantages, disadvantages, and applications of CW Radar. (11)

(c) Discuss the terms: (i) SHORAN, (ii) GCA, and (iii) ILS. (12)

Khulna University of Engineering & Technology
B. Sc. Engineering 4th Year 2nd Term (Regular) Examination, 2017
Department of Electrical and Electronic Engineering
EE 4209
Semiconductor Device Theory

Time: 3 hours Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.
(ii) Figures in the right margin indicate full marks.

Section A

Q1.	(a)	What do you mean by Reciprocal lattice and Brillouin zone?	(05)
	(b)	Explain the step by step procedure for the calculation of energy-band diagram and carrier density of a heterojunction structure by self-consistent quantum mechanical model.	(15)
	(c)	What are the properties of primitive unit cell and Wigner-Seitz cell? Draw a Wigner-Seitz cell in square lattice.	(08)
	(d)	Explain Bloch theorem. What is the physical significance of Hamiltonian matrix in solving Schrodinger equation?	(07)
Q2.	(a)	Why various types of transport models are essential to explain the semiconductor device physics? Derive Drift-diffusion transport model from Boltzmann transport model.	(15)
	(b)	What features are taken in Ballistic transport model that are not considered in Drift-diffusion transport model? Justify the following statement – "Ballistic conductor does not obey Ohm's law".	(10)
	(c)	Draw the dispersion relation of diatomic chain model of vibration. Which branches have lower energy? Justify.	(05)
	(d)	Briefly describe the dominant scattering mechanism in Si-semiconductor.	(05)
Q3.	(a)	From the equation of motion of the monoatomic chain model, derive the dispersion relation for the normal modes of vibration. Also, indicate the maximum allowable frequency in the monoatomic chain.	(15)
	(b)	What are the limitations of conventional BJTs? Draw the band diagram and doping profile of a typical n-p-n HBT.	(10)
	(c)	Prove that – "Two atoms are oscillating 180° out of phase with their centre of mass at rest for optical branches at the 1st Brillouin zone edge".	(10)
Q4.	(a)	What assumptions are made for deriving 1D tight binding model? Derive the dispersion relation for 1D tight binding model.	(15)
	(b)	What are the factors that determine the maximum limit of bandwidth in actual lattice? Draw the dispersion relation for the 1st Brillouin zone and indicate the bandwidth.	(10)
	(c)	Prove that the dispersion relation at the bottom of the band is parabolic in nature. Also, find out the effective mass of electron at the bottom of the band.	(10)

Section B

Q5.	(a)	What is meant by Schottky barrier? Draw the ideal energy-band diagram of a metal-semiconductor junction under forward and reverse bias.	(10)
	(b)	State and explain Anderson's rule.	(07)

(c) Determine the theoretical barrier height and built-in potential between tungsten and n-Si at room temperature. The work function for tungsten (W) is 4.55 V and electron affinity for Si is 4.01 V. Assume N_c and N_d for Si are 2.8×10^{19} and 10^{16} cm^{-3}, respectively. (06)

(d) Draw the energy-band diagram of the MOS capacitor with an n-type substrate for (a) a positive gate bias, (b) a moderate negative bias, and (c) a large negative gate bias. Also, show the accumulation of electrons, induced positive space charge region and inversion layer of holes. (12)

Q6. (a) Draw a typical structure of MOSFET. Derive the following ideal current-voltage relation for n-channel MOSFET in the non-saturation region: (17)

$$I_D = \frac{W\mu_n C_{ox}}{2L}[2(V_{GS} - V_T)V_{DS} - V_{DS}^2].$$

(b) What is meant by surface potential, inversion layer, threshold voltage and flat band condition? Derive the relation for gate bias necessary to generate flat band. (12)

(c) Determine the metal-semiconductor work function difference, Φ_{ms}, for a given MOS system and semiconductor doping. For an aluminium-silicon dioxide junction, Φ'_m = 3.20 V and for silicon-silicon dioxide junction x' = 3.25 V. We may assume that E_g = 1.12 V, $N_a = 10^{15}$ cm^{-3}, $N_i = 1.5\times10^{10}$ cm^{-3} and T = 300 K. (06)

Q7. (a) Why C-V characteristics are important? Derive the following minimum capacitance C'_{min} equation for a given MOS device: (12)

$$C'_{min} = \frac{\epsilon_{ox}}{t_{ox}+\left(\frac{\epsilon_{ox}}{\epsilon_s}\right)\chi_{dT}},$$

where the symbols have their usual meanings.

(b) Define homo and heterojunction of semiconductor. Classify heterojunction according to their relative band position. (08)

(c) Draw the band diagram of nP, nN, Np and pP. In which heterojunction will you get 2DEG? (15)

Q8. (a) How 2DEG is formed in heterojuction devices? Write down a comparison between continuous doping and δ-doping schemes for MODFET. (08)

(b) Derive the following sheet-carrier density equation of a δ-doped MODFET: (17)

$$n_s(V_G) = \frac{eN_d^+ d\delta + \epsilon\left[V_G - \left(\Phi_b - {\Delta E_c}/{e}\right)\right]}{eD},$$

where the symbols have their usual meanings.

(c) What are the limitations of single gate FET? How such limitations can be overcome using multiple gate? What is meant by FinFET? (10)

Khulna University of Engineering & Technology
B. Sc. Engineering 4th year 2nd Term (Regular) Examination, 2017
Department of Electrical and Electronic Engineering
EE 4211
Microwave Engineering

Time: 3 hours Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.
(ii) Figures in the right margin indicate full marks.
(iii) Smith chart may be provided on request.

Section A

Q1. (a) Deduce the following relationships of the voltage and current for a transmission line: (13)

$$V = V_s \cosh px \quad I_s Z_0 \sin hpx$$

$$I = I_s \cosh px \quad \frac{V_s}{Z_0} \sin hpx$$, where the symbols have their usual meanings.

(b) Deduce the general expression of input impedance of a transmission line. (12)

(c) Define reflection co-efficient and transmission co-efficient, and hence explain return loss and insertion loss. (10)

Q2. (a) What is impedance inverter? How a $\lambda/4$ line can be used as an impedance matching network? (10)

(b) In what conditions you can use a transmission line as resonators? —Explain (13)

(c) Calculate the length and position of the stub for matching of a transmission line in terms of λ. The line has its characteristics impedance of 600 Ω and its terminating impedance is 900 Ω. Calculate also the VSWR. (12)

Q3. (a) Define characteristics impedance of a T-line. Relate it with an infinite T-line. (11)

(b) Write short notes on (i) Beam area (ii) Aperture (iii) Main lobe and (iv) Directivity. (12)

(c) Write short notes on (i) Patch antenna and (ii) Rhombic antenna. (12)

Q4. (a) What is an isotropic radiator? Show that the Poynting vector varies inversely as the square of the distance from a point source radiator. (08)

(b) Let's say you have a source with hemispheric power pattern. Calculate the directivity. (08)

(c) Illustrate the arrays of two isotropic point sources for the following cases: (13)

(i) Two isotropic point sources of same amplitude and phase

(ii) Two isotropic point sources of same amplitude but in-phase quadrature.

(d) State and explain the principle of pattern multiplication. (06)

Section B

Q5. (a) "Smith chart is the magical tool for solving the transmission line problems"—Explain. Also show that Smith chart represents a family of circles with constant resistances and reactances. (15)

(b) A lossless transmission line of characteristic impedance R_0=300 Ω is connected to a load impedance $Z_L = 150/[0.75 + j1.5]$ Ω. A short-circuited lossless stub is required (20)

to match the load with the line. The characteristic impedance of the stub is 200 Ω and the frequency is 3 GHz. Find

(i) The 2nd I_{min} from the load

(ii) The load impedance at 5 cm from the load

(iii) The stub position closet to the load

(iv) The stub length and

(v) VSWR

Q6. (a) Shortly describe the limitations of vacuum tubes over advanced O and M-type tubes. How these limitations are overcome? (13)

(b) Determine the wave equations in TM modes in a rectangular waveguides. Also find out the cut-off frequency and propagation constant. (15)

(c) Design a rectangular waveguide to carry only the TE_{10} mode at a frequency of 500 MHz. (07)

Q7. (a) What are the basic differences between O and M-type tubes? (06)

(b) Explain the construction and principle of operation of a two-cavity Klystron. (14)

(c) A reflex Klystron operates under the following conditions: (15)

$V_0 = 600$ V L = 1 mm

$R_{sh} = 15$ kΩ $e/m = 1.759 \times 10^{11}$ (MKS system)

$f_r = 9$ GHz.

The tube is oscillating at f_r at the peak of the n = 2 or $1\,3/4$ mode. Assume that the transit time through the gap and beam loading can be neglected.

(i) Find the value of the repeller voltage V_r.

(ii) Find the direct current necessary to give a microwave gap voltage of 200 V.

(iii) What is the electronic efficiency under this condition?

Q8. (a) Clearly explain the working principle of Magnetron. Why carcinotrons are suitable for effective RADAR jamming. (12)

(b) What are the characteristics of TWTs? Explain the construction and working principle of a TWT amplifier. (15)

(c) A linear magnetron has the following operating parameters: (08)

Anode voltage: $V_0 = 10$ kV

Cathode current: $I_0 = 1$ A

Magnetic flux density: $B_0 = 0.01$ Wb/m^2

Distance between cathode and anode: d = 5 cm

Compute:

(i) The Hall cut-off voltage for a fixed B_0

(ii) The Hall cut-off magnetic flux density for a fixed V_0.

Khulna University of Engineering & Technology
B. Sc. Engineering 4th Year 2nd Term (Regular) Examination, 2017
Department of Electrical and Electronic Engineering
EE 4217
Power Plant Engineering

Time: 3 hours Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.
(ii) Figures in the right margin indicate full marks.

Section A

Q1. (a) Classify power plants and different categories of electrical loads. (10)

(b) What is meant by power plants? Discuss the site selection criteria for thermal and hydroelectric power plants. (10)

(c) What are the perplexities introduced by variable load on power plant? (07)

(d) What is yearly load curve? Discuss average load and load factor from yearly load curve. (08)

Q2. (a) What are the factors to be considered in forecasting load? (05)

(b) Deduce the condition to achieve the best economy in load sharing between power plants. (10)

(c) State the advantages of the diversity of load in a power system and prove that the load factor of a power system is improved by an increase in the diversity of load. (10)

(d) A power station has a maximum demand of 15 kW, load factor of 70%, plant capacity factor of 52.5% and plant use factor of 85%. Determine the (i) daily energy produced, (ii) reserve capacity of the plant, (iii) hours per day not in service, and (iv) maximum energy that could have been produced daily if the plant was in use all the time. (10)

Q3. (a) Classify different types of substation according to their service requirement. What is underground substation? (08)

(b) What is bathtub curve? Why failure rate is assumed constant during the useful life period. (08)

(c) Ten thousand new oil circuit reclosures (OCR) are put in service. They have a constant failure rate of 0.1 per year. How many units of the original 10,000 will still be in service after 10 years? How many of the original will fail in year 10? (06)

(d) The incremental fuel costs for two units of a plant are (13)

$$\lambda_1 = \frac{\mathrm{d}F_1}{\mathrm{d}P_1} = 0.96P_1 + 640, \quad \lambda_2 = \frac{\mathrm{d}F_2}{\mathrm{d}P_2} = 0.64P_2 + 768,$$

where F is in Taka per hour (Tk/hr) and P is in megawatts (MW). If both units operate at all times and maximum and minimum loads on each unit are 550 and 100 MW, respectively, find the savings in Tk/hr for economic dispatch of load between the units compared with their sharing the output equally when the total plant output is 600 MW and 1100 MW.

Q4. (a) How can reliability of series and parallel systems be determined if individual components have equal failure rate? (12)

(b) Explain Bayes' theorem. For a series-parallel system, prove that Bayes' theorem can be used to find the reliability of the overall system. (08)

(c) What is MTTF? Find the MTTF of a system with n spares to support one equipment. Compare it with MTTF of parallel system. (08)

(d) What is MTTR? If 1 failure was observed over a year, what failure rate will give the 97% upper confidence limit? (07)

Section B

Q5. (a) Define nuclear power plant. Discuss the factors which go in favour of nuclear power plant as compared to other types of power plants. (08)

(b) What are the differences between chemical and nuclear reactions? Write down the different methods for producing neutrons. (07)

(c) What is elastic and inelastic scattering? Show that the mean free path of a neutron is the reciprocal of the macroscopic cross-section. (10)

(d) A newly born neutron of 4.8 MeV is to be slowed to 0.025 eV in a water moderator. Assuming all collisions to be elastic, calculate the logarithmic energy decrement representing the neutron energy loss per elastic collision and the number of collisions necessary. (10)

Q6. (a) Briefly explain fissile and fertile materials. Show the reaction by which fertile materials U^{238} and Th^{232} can be converted to fissile materials Pu^{239} and U^{233}, respectively. (10)

(b) Describe the neutron life cycle in a thermal reactor with proper diagram. Also, explain the significance of effective multiplication factor. (10)

(c) Draw and explain the block diagram of a pressurized water reactor. (07)

(d) What are the essential properties of a good moderator and coolant in a nuclear power plant? Why a fast breeder reactor does not require any moderator? (08)

Q7. (a) Draw and explain the essential parts of a steam power plant. Discuss the disadvantages associated with this type of plant. (12)

(b) What is a penstock? Describe the various factors which influence the choice of site for a hydro-electric plant. (07)

(c) Explain the energy generation from the following sources: (i) Geothermal and (ii) MHD generator. (06)

(d) Calculate the average power in kW that can be generated in a hydro-electric project from the following data: catchment area = 5×10^9 m^2, mean head, H = 30 m, annual rainfall = 1.25 m, yield factor = 80% and overall efficiency = 70%. If the load factor is 40%, what is the rating of the generator installed? (10)

Q8. (a) With neat sketch, describe the working principle of wind energy conversion system. (10)

(b) What is tidal power plant? Classify it and describe the single basin two way tidal power plant. (10)

(c) Explain briefly photovoltaic cell. Derive the expression of conversion efficiency of a solar cell. (15)

Khulna University of Engineering & Technology

B. Sc. Engineering 4th year 2nd Term (Regular) Examination, 2017

Department of Electrical and Electronic Engineering

EE 4223

High Voltage DC and Flexible AC Transmission

Time: 3 hours Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.
(ii) Figures in the right margin indicate full marks.

Section A

Q1. (a) Describe the advantages and disadvantages of HVDC transmission over HVAC transmission. What is break even distance? Show the bi-polar link in HVDC. (12)

(b) Draw the schematic diagram of a monopolar HVDC system and explain the functions of each component precisely. (15)

(c) State the operating mode of VSC. How does a VSC act as an inverter and reactive power controller? Explain with proper vector diagrams. (08)

Q2. (a) Describe the operation of a six pulse grid controlled converter with overlap less than 60 degree. Obtain the expression of output dc voltage, $V_d = V_{d0}\cos\alpha \quad R_c I_d$, where the symbols bear usual meanings. (25)

(b) A six-pulse HVDC converter is connected to 330 kV, 50 Hz AC grid using a 330 kV/220 kV, 800 MVA, X_t = 12% transformer. Calculate the commutation overlap angle if the converter is operating at 10° firing angle and an 1800 A DC current. Describe how transformer reactance affects commutation overlap. (10)

Q3. (a) What are the limitations of shunt-passive filter? Explain the basic principle of operation of a shunt-active filter with net sketch of block diagram and proper waveforms. (12)

(b) Mention some advantages of VSC over LCC. Draw the schematic diagram of a VSC substation and explain the different components briefly. (11)

(c) Why are the harmonics introduced in converters? Show that harmonics in a twelve pulse group is much more less than other configurations. Deduce the harmonic values for Y-Δ and Y-Y 12-pulse converters. (12)

Q4. (a) What is the importance of multi-level converter? Describe the operation of a three-level flying capacitor multilevel converter. (10)

(b) Draw the schematic diagram of half-bridge and full-bridge MMC cell. Mention some important operational advantages of full-bridge over half-bridge MMC. (10)

(c) A single-phase VSC inverter has a pure inductive load with L = 20 mH. The inverter operates in a square wave fashion with an AC frequency of 50 Hz and Dc voltage of 200 V. (15)

(i) Express the instantaneous converter voltage and current.
(ii) Calculate the peak and rms load current, and
(iii) Calculate the power absorbed by the load.

Section B

Q5. (a) Draw the schematic diagram of a single phase TCR and explain its working principle. Show that for a TCR (11)

$$B_{TCR}(\sigma) = B_{max}\left(\frac{\sigma \quad \sin\sigma}{\pi}\right).$$

(b) Describe the operation of a 6-pulse TCR-TSC compensator with three TSCs. Explain its current characteristics. (07)

(c) Draw the schematic diagram of a general SVC control system. Explain its operation. (09)

(d) Explain the operation of a pulse ratio modulated (PRM) megawatt transducer. (08)

Q6. (a) Draw the schematic diagram of a UPFC with back to back VSCs. Explain the control modes of UPFC for different conditions. (12)

(b) Describe the application of SVC in power system to (i) increase steady state power transfer capacity and (ii) power system damping control. (10)

(c) A SVC connected to a 735 kV system has a reactive power range of 350 MVAR production to 100 MVA absorption. The droop is set to 4%. The system short circuit level is specified as follows: (13)

Maximum short-circuit current: 50 kA

The minimum short-circuit current under normal operating conditions: 5 kA

The minimum short-circuit current during system restoration after loss of transmission line: 500 A.

Determine

(i) The per unit regulator gain that ensures stable operation from 5 kA to 50 kA system short-circuit current

(ii) Show the change of voltage-control response for the system variation with regulator setting as mentioned

(iii) Determine the regulator gain for stable operation if the system short-circuit level range 500 A to 50 kA.

Q7. (a) Show the configuration of a TCSC and explain its modes of operation. What are the advantages of TCSC? (12)

(b) Describe the application of TCSC for improvement of power system damping and power system stability. (12)

(c) Explain the independent control of power and var between a generator bus and load bus. (11)

Q8. (a) Draw and explain the operating principle of a STATCOM. Deduce the operating constraint of the STATCOM for active power exchange via DC link. What are the control functions of STATCOM? (14)

(b) Deduce the steady state mathematical model of a STATCOM. (10)

(c) Describe the architecture of a SSSC. Explain its operation with modes of real and reactive power changes. (11)

Khulna University of Engineering & Technology

B. Sc. Engineering 4th Year 2nd Term (Regular) Examination, 2017

Department of Electrical and Electronic Engineering

EE 4235

Digital Image Processing

Time: 3 hours Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.

(ii) Figures in the right margin indicate full marks.

Section A

Q1. (a) Two images (10)

(b) Two images are given below: (10)

A = | 5 | 100 |
|---|---|
| 255 | 0 |

B = | 25 | 200 |
|---|---|
| 60 | 255 |

(i) What would be the resultant pixel gray values at all location in the enhanced image when a NAND and a NOR logical operation will be performed.

(ii) Perform the multiplication between A & B images.

(iii) Perform blend between A & B, where the blending ratio is 0.4.

(c) What are the perplexities introduced by variable load on power plant? (07)

(d) What is yearly load curve? Discuss average load and load factor from yearly load curve. (08)

Q2. (a) What are the factors to be considered in forecasting load? (05)

(b) Deduce the condition to achieve the best economy in load sharing between power plants. (10)

(c) State the advantages of the diversity of load in a power system and prove that the load factor of a power system is improved by an increase in the diversity of load. (10)

(d) A power station has a maximum demand of 15 kW, load factor of 70%, plant capacity factor of 52.5% and plant use factor of 85%. Determine the (i) daily energy produced, (ii) reserve capacity of the plant, (iii) hours per day not in service, and (iv) maximum energy that could have been produced daily if the plant was in use all the time. (10)

Q3. (a) Classify different types of substation according to their service requirement. What is underground substation? (08)

(b) What is bathtub curve? Why failure rate is assumed constant during the useful life period. (08)

(c) Ten thousand new oil circuit reclosures (OCR) are put in service. They have a constant failure rate of 0.1 per year. How many units of the original 10,000 will still be in service after 10 years? How many of the original will fail in year 10? (06)

(d) The incremental fuel costs for two units of a plant are (13)

$$\lambda_1 = \frac{\mathrm{d}F_1}{\mathrm{d}P_1} = 0.96P_1 + 640, \quad \lambda_2 = \frac{\mathrm{d}F_2}{\mathrm{d}P_2} = 0.64P_2 + 768,$$

where F is in Taka per hour (Tk/hr) and P is in megawatts (MW). If both units operate at all times and maximum and minimum loads on each unit are 550 and 100 MW, respectively, find the savings in Tk/hr for economic dispatch of load between the units compared with their sharing the output equally when the total plant output is 600 MW and 1100 MW.

Q4. (a) How can reliability of series and parallel systems be determined if individual components have equal failure rate? (12)

(b) Explain Bayes' theorem. For a series-parallel system, prove that Bayes' theorem can be used to find the reliability of the overall system. (08)

(c) What is MTTF? Find the MTTF of a system with *n* spares to support one equipment. Compare it with MTTF of parallel system. (08)

(d) What is MTTR? If 1 failure was observed over a year, what failure rate will give the 97% upper confidence limit? (07)

Section B

Q5. (a) Define nuclear power plant. Discuss the factors which go in favour of nuclear power plant as compared to other types of power plants. (08)

(b) What are the differences between chemical and nuclear reactions? Write down the different methods for producing neutrons. (07)

(c) What is elastic and inelastic scattering? Show that the mean free path of a neutron is the reciprocal of the macroscopic cross-section. (10)

(d) A newly born neutron of 4.8 MeV is to be slowed to 0.025 eV in a water moderator. Assuming all collisions to be elastic, calculate the logarithmic energy decrement representing the neutron energy loss per elastic collision and the number of collisions necessary. (10)

Q6. (a) Briefly explain fissile and fertile materials. Show the reaction by which fertile materials U^{238} and Th^{232} can be converted to fissile materials Pu^{239} and U^{233}, respectively. (10)

(b) Describe the neutron life cycle in a thermal reactor with proper diagram. Also, explain the significance of effective multiplication factor. (10)

(c) Draw and explain the block diagram of a pressurized water reactor. (07)

(d) What are the essential properties of a good moderator and coolant in a nuclear power plant? Why a fast breeder reactor does not require any moderator? (08)

Q7. (a) Draw and explain the essential parts of a steam power plant. Discuss the disadvantages associated with this type of plant. (12)

(b) What is a penstock? Describe the various factors which influence the choice of site for a hydro-electric plant. (07)

(c) Explain the energy generation from the following sources: (i) Geothermal and (ii) MHD generator. (06)

(d) Calculate the average power in kW that can be generated in a hydro-electric project from the following data: Catchment area = 5×10^9 m^2; mean head, H = 30 m, annual rainfall = 1.25 m, yield factor = 80% and overall efficiency = 70%. If the load factor is 40%, what is the rating of the generator installed? (10)

Q8. (a) With neat sketch, describe the working principle of wind energy conversion system. (10)

(b) What is tidal power plant? Classify it and describe the single basin two way tidal power plant. (10)

(c) Explain briefly photovoltaic cell. Derive the expression of conversion efficiency of a solar cell. (12)

Khulna University of Engineering & Technology
B. Sc. Engineering 4th year 2nd Term (Regular) Examination, 2017
Department of Electrical and Electronic Engineering
EE 4237
Special Machines and AC Drives

Time: 3 hours Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.
(ii) Figures in the right margin indicate full marks.

Section A

Q1. (a) Show that a dc shunt motor cannot operate with ac supply but a dc series motor can operate with ac supply. Why is the performance with ac supply worst than dc supply? Explain the technique to improve the performance with ac supply. (14)

(b) Explain repulsion start principle. Describe the characteristic of repulsion start induction run motor. (11)

(c) Draw the circuit diagram of an amplidyne and discuss its principle of operation. Where is an amplidyne used? (10)

Q2. (a) Show that a hysteresis motor is a constant torque self starting motor. Describe its rotor construction. Mention some applications of the motor. (13)

(b) Describe the construction of a synchronous reluctance motor. How is the motor pulled into synchronism? Show that rotor of synchronous reluctance motor can be constructed in the laboratory. (12)

(c) Explain the construction and operation of a linear induction motor. Mention some applications of the motor. (10)

Q3. (a) Describe the different types of rotors used for stepper motor. Explain the operation of a VR type reluctance motor with half-step operation with truth table and diagram. (13)

(b) Show that an ac servomotor has better performance than a dc servomotor. Explain its characteristics and constructional features. (12)

(c) A stepper motor has a step angle of 1.8° and is driven at 4000 pps. Determine (i) resolution (ii) motor speed (iii) number of pulses required to rotate the shaft through 54°. (10)

Q4. (a) What are promising permanent magnet materials for motor construction? Describe the construction and mathematical model of a Brushless DC motor. Describe a control system for the motor. (11)

(b) Explain the differences between interior and surface permanent magnet motors. Describe a mathematical model and control action of an IPM motor. (10)

(c) Classify synchros. Write its applications. (06)

(d) The rotor of a control transmitter (CX) is excited by a single phase ac voltage of rms value 20 V. Find the value of E_{1x}, E_{2x}, and E_{3x} for rotor angle $\alpha = +40°$ and $-40°$. Assume the stator/rotor turns ratio as unity. (08)

Section B

Q5. (a) Describe the flow of energy in an electromechanical energy conversion system via a coupling field. (11)

(b) Find the energy and co-energy of a multiply-excited magnetic field system. Also show that the use of a co-energy function of the terminal currents simplifies the determination of torque or force. (14)

(c) The relay shown in Fig. Q5(c) is made from infinitely-permeable magnetic material with a movable plunger also of infinitely permeable material. The height of the plunger is much greater than the air gap length (h >> g). Calculate the magnetic stored energy as a function of plunger position ($0 < x < d$) for N = 1000 turns, g = 2.0 mm, d = 0.15 m, l = 0.1 m and i = 10 A. (10)

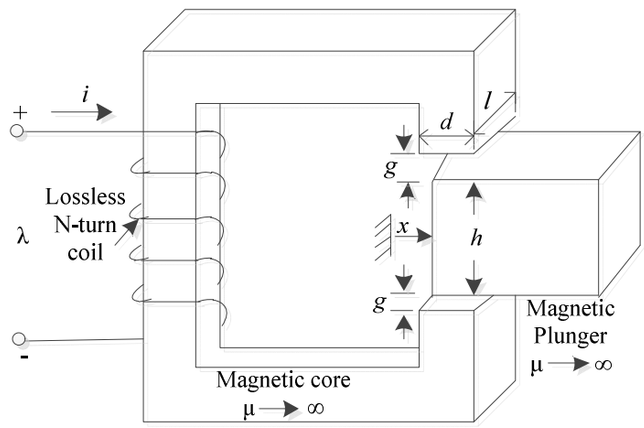

Fig. Q5(c).

Q6. (a) Write down the advantages of closed loop control of ac drives. What are the basic building blocks of ac drives? Also show the interconnections among the blocks. (10)

(b) Write a short note on regenerative braking in AC drives. Do you think the regenerative braking concept can be applied to charge the battery of an electric vehicle of 48 V? Justify your answer with necessary circuit diagram. (15)

(c) A 440 V, 50 Hz, 6-pole, Y-connected wound rotor motor has the following parameters: $R_s = 0.5\ \Omega$, $R_r' = 0.4\ \Omega$, $X_s = X_r' = 1.2\ \Omega$, $X_m = 50\ \Omega$, and stator to rotor turns ratio is 3.5. Motor is controlled by static rotor resistance control. External resistance is chosen such that the breakdown torque is produced at standstill for a duty ratio of zero. Calculate the value of external resistance. (10)

Q7. (a) What is the principle of v/f control? (05)

(b) Explain the differences between scalar control and vector control. Describe the foundation of vector control with relevant phasor diagram. (10)

(c) Write down a basic difference between direct- and indirect-vector controls. Discuss indirect-vector control mechanism for an induction motor drive. (10)

(d) Draw the block diagram of a direct vector control scheme and explain its operation. Describe a method to find out rotor flux position. (10)

Q8. (a) What do you understand about the saliency of a salient-pole synchronous motor drive? Write down the torque expression of a salient-pole-synchronous motor drive and show the saliency effect graphically by using the relation between the torque and torque-angle. (13)

(b) Discuss the principle of operation of a load-commutated inverter based synchronous-motor drive. (12)

(c) Draw the basic block diagram of brushless dc and ac motor drives. (10)