MIZORAM PUBLIC SERVICE COMMISSION

TECHNICAL COMPETITIVE EXAMINATIONS FOR JUNIOR GRADE OF MIZORAM ENGINEERING SERVICE (M.E.S.) UNDER PUBLIC HEALTH DEPARTMENT, GOVERNMENT OF MIZORAM, MARCH, 2019.

ELECTRICAL ENGINEERING
PAPER - II

Time Allowed : 3 hours FM : 200

SECTION - A *(Multiple Choice questions)*

(100 Marks)

All questions carry equal mark of 2 each. Attempt all questions.

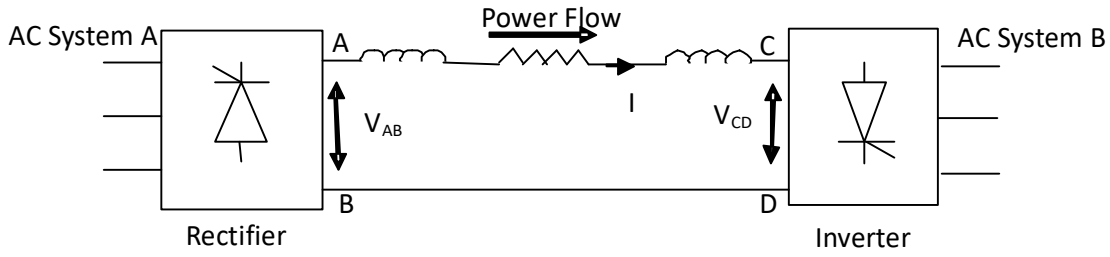
This Section should be answered only on the ***OMR Response Sheet*** *provided.*

1. The transfer function of a phase lag compensator is given by $\frac{1+Ts}{1+aTs}$ where a > 1 and T > 0. The maximum phase shift provided by such a compensator is

(a) $\tan^{-1}\left(\frac{a+1}{a-1}\right)$ (b) $\tan^{-1}\left(\frac{a-1}{a+1}\right)$

(c) $\sin^{-1}\left(\frac{a+1}{a-1}\right)$ (d) $\sin^{-1}\left(\frac{a-1}{a+1}\right)$

2. Power is transferred from system A to system B by an HVDC link as shown in the figure. If the voltage V_{AB} and V_{CD} are as indicated in figure, and I > 0, then



(a) $V_{AB} < 0, V_{CD} < 0, V_{AB} > V_{CD}$ (b) $V_{AB} > 0, V_{CD} > 0, V_{AB} < V_{CD}$

(c) $V_{AB} > 0, V_{CD} > 0, V_{AB} > V_{CD}$ (d) $V_{AB} > 0, V_{CD} < 0$

3. In a dc machine, for the same value of f, Z and N, which one of the following statements is correct?

(a) Armature emf is more with wave winding than with lap winding.

(b) Armature emf is less with wave winding than with lap winding.

(c) Armature emf depends on whether the machine is running as a motor or a generator.

(d) Armature emf is the same as long as the flux density in the air gap remains the same.

4. If the gain margin of a certain feedback system is given as 20 dB, the Nyquist plot will cross the negative real axis at the point

(a) s = -0.05 (b) s = -0.2

(c) s = -0.1 (d) s = -0.01

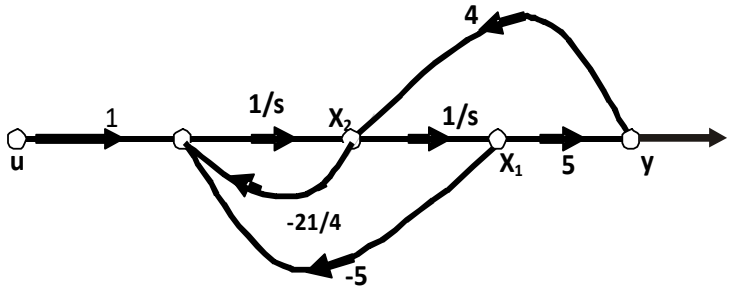
5. A three phase, 33 kV oil circuit breaker is rated 1200 A, 2000 MVA, 3 sec. The symmetrical breaking current is

(a) 1220 A
(b) 3600 A
(c) 35 kA
(d) 104.8 kA

6. A self-excited dc shunt generator, driven by its prime-mover at the rated speed fails to build up voltage across its terminals at no-load. What reason can be assigned for this?

(a) The field circuit resistance is higher than the critical resistance.
(b) The initial shunt field mmf does not assist the residual magnetism
(c) One of the inter-pole connections is reversed
(d) The brush-axis shifts slightly from the geometrical neutral axis of the machine

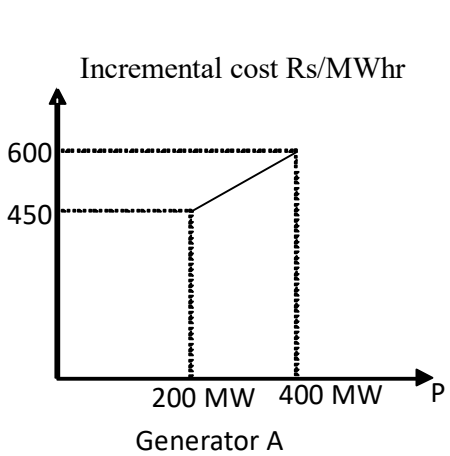
7. A state flow graph is shown below

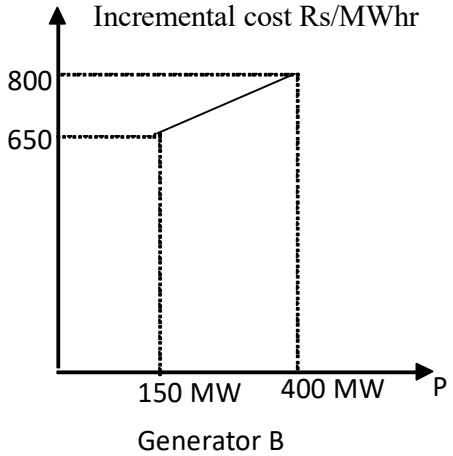


The system is

(a) Observable and controllable
(b) Controllable only
(c) Observable only
(d) None of these

8. The incremental cost curves in Rs/MWhr for two generators supplying a common load of 700 MW are shown in the figures. The maximum and minimum generation limits are also indicated. The optimum generation schedule is :





(a) Generator A: 400 MW, Generator B: 300 MW
(b) Generator A: 350 MW, Generator B: 350 MW
(c) Generator A: 450 MW, Generator B: 250 MW
(d) Generator A: 425 MW, Generator B: 275 MW

9. The no-load speed of a dc shunt motor is given as 1200 rpm, the power developed by the machine will be maximum at a speed of

(a) 1200 rpm
(b) 2400 rpm
(c) 4800 rpm
(d) 600 rpm

10. For an electrically heated temperature controlled liquid heater, the best controller is

(a) Single-position controller
(b) Two- position controller
(c) Floating controller
(d) Proportional-position controller

11. In the thermal power plants, the pressure in the working fluid cycle is developed by

(a) condenser
(b) super heater
(c) feed water pump
(d) turbine

12. If the temperature is increased, the speed of a series and shunt motor

(a) increases, decreases
(b) both increases
(c) both decreases
(d) decreases, increases

13. A minimum phase system has fourteen poles and two zeros. The shape of its highest frequency asymptote in its Bode plot is

(a) -240 dB/decade
(b) -280dB/decade
(c) -320dB/ Decade
(d) -40 dB/decade

14. For harnessing low variable waterheads, the suitable hydraulic turbine with high percentage of reaction and runner adjustable vanes is

(a) Kaplan
(b) Francis
(c) Pelton
(d) Impeller

15. Which one of the following is not a necessary condition to be satisfied for synchronizing an incoming alternator to an already operating alternator?

(a) Same voltage magnitude
(b) Same frequency
(c) Same prime mover speed
(d) Same phase sequence

16. The system $\frac{900}{s(s+1)(s+9)}$ is to be such that its gain-crossover frequency becomes same as its uncompensated phase crossover frequency and provides a 45^{o} phase margin. To achieve this, one may use

(a) a lag compensator that provides an attenuation of 20 dB and a phase lag of 45^{o} at the frequency of $3\sqrt{3}$ rad/s.
(b) a lead compensator that provides an amplification of 20 dB and a phase lead of 45^{o} at the frequency of 3 rad/s.
(c) a lag-lead compensator that provides an amplification of 20 dB and a phase lag of 45^{o} at the frequency of $\sqrt{3}$ rad/s.
(d) a lag-lead compensator that provides an attenuation of 20 dB and phase lead of 45^{o} at the frequency of 3 rad/s.

17. A 645 MVA, 24 kV synchronous generator is feeding full-load at 0.9 pf lagging at rated voltage. The generator has a synchronous reactance of 1.2 W. Reactive power drawn by load is

(a) 580.5 MVAR
(b) 281 MVAR
(c) 389 MVAR
(d) None of these

18. The torque of a reluctance motor can be effectively increased by

(a) increasing reluctance of the magnetic circuit along the direct axis
(b) decreasing the reluctance of the magnetic circuit along the quadrature axis
(c) increasing the ratio of the quadrature axis reluctance to direct axis reluctance
(d) decreasing the ratio of the quadrature axis reluctance to direct axis reluctance

19. While designing controller, the advantage of pole-zero cancellation is

(a) the system order is increased
(b) the system order is reduced
(c) the cost of controller becomes low
(d) system's error reduced to optimum levels

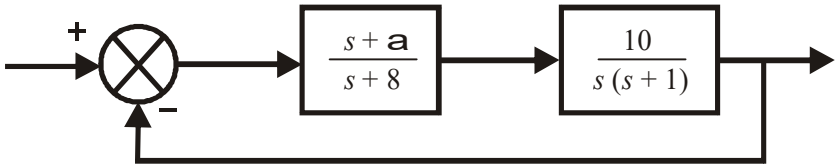
20. Under no load conditions, the current in a transmission line is because of

(a) capacitance effect
(b) corona effect
(c) proximity effect
(d) back flow from earth

21. In a shaded-pole induction motor, the rotor runs from the

(a) shaded portion to the unshaded portion of the pole while the flux in the former leads that in the latter
(b) shaded portion to the unshaded portion of the pole while the flux in the former lags that in the latter
(c) unshaded portion to the shaded portion while the flux in the former leads that in the latter
(d) unshaded portion to the shaded portion while the flux in the former lags that in the latter

22. For the below control system, the root locus has breakway or breakin points at



(a) s = -1.268
(b) s = -4.732
(c) s = -3.654
(d) None of these

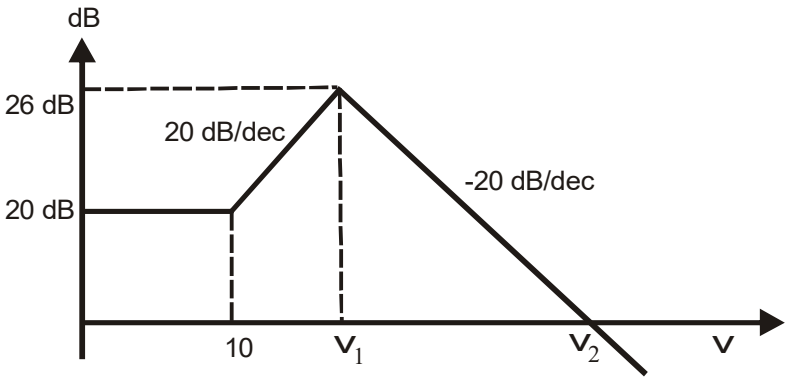
23. In load flow analysis, the load connected at a bus is represented as

(a) constant current drawn from the bus
(b) constant impedance connected at the bus
(c) voltage and frequency dependent source at the bus
(d) constant real and reactive power drawn from the bus

24. In an induction motor, when the number of stator slots is equal to an integral multiple of rotor slots

(a) There may be a discontinuity in torque-slip characteristics
(b) A high starting torque will be available
(c) The maximum torque will be high
(d) The machine may fail to start

25. The magnitude-frequency response of a control system is given in the figure. The value of v_1 and v_2 are respectively



(a) 100 and 400
(b) 20 and 400
(c) 20 and 200
(d) 10 and 200

26. If the reference bus is changed in two load flow buses with same system data and power obtained for reference bus taken as specified P and Q in the latter run

(a) the system losses will be unchanged but complex bus voltages will change

(b) the system losses will be changed but complex bus voltages remains unchanged

(c) the system losses as well as complex bus voltages will change

(d) The system losses as well as complex bus voltages will be unchanged

27. In a 3-phase induction motor, the resultant flux is of a constant nature and is

(a) equal to $\mathtt{f}_{\mathrm{m}}$, where $\mathtt{f}_{\mathrm{m}}$ is maximum flux due to any phase

(b) 1.5 time maximum value of flux due to any phase

(c) $\frac{\sqrt{3}}{2}$ times maximum value of flux due to any phase

(d) $3\mathtt{f}_{\mathrm{m}}$

28. The characteristics equation of a feedback control system is given by $s^3+5s^2+(K+6)s+K=0$. In the root of loci diagram, the asymptotes of the root loci for large 'K' meet at a point in the s-plane whose co-ordinates are

(a) (2, 0) (b) (-1, 0)

(c) (-2, 0) (d) (-3, 0)

29. Zero sequence currents can flow from a line to transformer bank if the windings are in

(a) grounded star-delta (b) delta-star

(c) star-grounded star (d) detla-delta

30. The equivalent circuit of a transformer has reactances X_1 , $X_2^{'}$ and magnetizing reactance X_M. Their magnitudes satisfy

(a) $X_1 \square X_2^{'} \square X_M$ (b) $X_1 \square X_2^{'} \square X_M$

(c) $X_1 \approx X_2^{'} \square X_M$ (d) $X_1 \approx X_2^{'} \square X_M$

31. A system has a damping ratio of 1.25, a natural frequency of 200 rad/s and DC gain of 1. The response of the system to a unit step input is

(a) $1+\frac{5}{3}e^{-50t}-\frac{2}{3}e^{-150t}$ (b) $1-\frac{4}{3}e^{-100t}+\frac{1}{3}e^{-400t}$

(c) $1+\frac{1}{3}e^{-100t}-\frac{4}{3}e^{-400t}$ (d) $1+\frac{2}{3}e^{-50t}-\frac{5}{3}e^{-150t}$

32. Tick the correct statement:

(a) The negative and zero sequence voltages are maximum at the fault location and decrease towards neutral.

(b) The negative and zero sequence voltages are minimum at the fault point and increase towards neutral.

(c) The negative sequence is maximum and zero sequence is minimum at the fault point and decrease and increase respectively towards the neutral.

(d) The negative sequence and zero sequence currents do not exist at the fault point location.

33. A rotating electrical machine its self-inductances of both the stator and the rotor windings, independent of the rotor position will be definitely not develop

(a) starting torque (b) synchronizing torque

(c) hysteresis torque (d) reluctance torque

34. The correct sequence of steps needed to improve system stability is

(a) reduce gain, use negative feedback, insert derivative action

(b) reduce gain, insert derivative action, use negative feedback

(c) insert derivative action, use negative feedback, reduce gain

(d) use negative feedback, reduce gain, insert derivative action.

35. By increasing the transmission voltage to double of its original value, the same power can be despatched keeping the line loss

(a) Equal to original value

(b) half the original value

(c) double the original value

(d) one- fourth of original value

36. A 3-phase induction motor is driving a constant torque load at rated voltage and frequency. If both voltage and frequency are halved, following statements relate to the new condition if stator resistance, leakage reactance and core loss are ignored.

i. The difference between synchronous speed and actual speed remains same

ii. The airgap flux remains same

iii. The stator current remains same

iv. The p.u. slip remains same

Among the above, current statements are

(a) All

(b) i, ii and iii

(c) ii, iii and iv

(d) i and iv

37. The state equation of a LTI system is $\dot{x} = \begin{bmatrix} 0 & 2 \\ -2 & 0 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$

The state transition matrix is

(a) $\begin{bmatrix} \cos 2t & \sin 2t \\ -\sin 2t & \cos 2t \end{bmatrix}$

(b) $\begin{bmatrix} \cos 2t & -\sin 2t \\ \sin 2t & \cos 2t \end{bmatrix}$

(c) $\begin{bmatrix} \sin 2t & \cos 2t \\ -\cos 2t & \sin 2t \end{bmatrix}$

(d) $\begin{bmatrix} \sin 2t & -\cos 2t \\ \cos 2t & \sin 2t \end{bmatrix}$

38. A cable has inductance of 0.22 mH per km and capacitance of 0.202 mF per km. The surge impedance of the cable is

(a) 28 W

(b) 33 W

(c) 42 W

(d) 50 W

39. A synchronous generator is feeding a zero power factor (lagging) load at rated current. The armature reaction is

(a) magnetizing

(b) demagnetizing

(c) cross-magnetizing

(d) ineffective

40. For the transfer function $\frac{Y(s)}{U(s)} = \frac{s+3}{(s+1)(s+2)}$

The state model is: $\dot{x} = A \cdot x + B \cdot u,\ y = C \cdot x.$ The A, B, C are

(a) $\begin{bmatrix} 1 & 0 \\ -2 & 2 \end{bmatrix}, \begin{bmatrix} 0 \\ 1 \end{bmatrix}, \begin{bmatrix} 0 & 1 \end{bmatrix}$

(b) $\begin{bmatrix} 1 & 0 \\ 2 & 2 \end{bmatrix}, \begin{bmatrix} 0 \\ 1 \end{bmatrix}, \begin{bmatrix} 0 & 1 \end{bmatrix}$

(c) $\begin{bmatrix} -1 & 0 \\ 2 & -2 \end{bmatrix}, \begin{bmatrix} 0 \\ 1 \end{bmatrix}, \begin{bmatrix} 0 & 1 \end{bmatrix}$

(d) None of these

41. Equal area criterion gives the information regarding

(a) stability region
(b) absolute stability
(c) relative stability
(d) swing curves

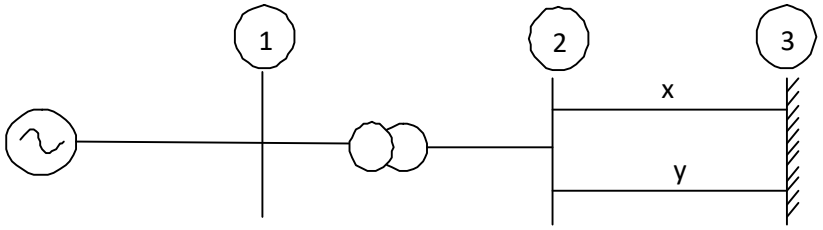
42. In a transformer the hysteresis losses are 100 K when the input voltage form factor is 2.11. If the input voltage form factor is 1.40, the hysteresis loss will be

(a) 140 K
(b) $\frac{140}{111}$ K
(c) 200 K
(d) 70 K

43. Which of the following is the non-linearity caused by servomotor?

(a) Static friction
(b) Backlash
(c) Saturation
(d) None of these

44. A generator with constant 1.0 p.u. terminal voltage supplies power through a step-up transformer of 0.12 p.u. reactance and a double-circuit line to an infinite bus bar as shown in the figure. The infinite bus voltage is maintained at 1.0 p.u. Neglecting the resistances and suspectances of the system, the steady state stability power limit of the system is 6.25 p.u. If one of the double-circuit is tripped, then resulting steady state stability power limit in p.u. will be,



(a) 12.5 p.u.
(b) 3.125 p.u.
(c) 10.0 p.u.
(d) 5.0 p.u.

45. Two transformers T_1 and T_2 have identical ratings. Transformer T_1 is designed for flux density of 1.15Wb/m^2 and transformer T_2 is designed for flux density of 1.45 Wb/m^2. From the above information it can be concluded that

(a) both transformers will operate at 0.8 p.f. lagging.
(b) both transformers will have identical losses at full load.
(c) the weight of transformer T_1 will be more than that of transformer T_2.
(d) the regulation of transformer T_1 will be better than that of transformer T_2.

46. An amplidyne can give which of the following characteristics?

(a) Constant current
(b) Constant voltage
(c) Constant current as well as constant voltage
(d) Constant current, constant voltage and constant power

47. A synchronous generator having an inertia constant of 6.0 MJ/MVA is delivering power of 1.0 pu to an infinite bus through a purely reactive network. Suddenly a fault occurs reducing the generator output power to zero. The maximum power that could be delivered is 2.5 per unit. The critical clearing angle is

(a) 89.27°
(b) 23.58°
(c) 21.95°
(d) 59.33°

48. In the potier's triangle, the Potier reactance drop per phase is 22 volts per phase at 88 amperes per phase. The Potier's reactance per phase is

(a) 0.22 (b) 0.25

(c) 0.30 (d) 0.44

49. If the voltage across the units in a two unit suspension insulator is 60% and 40% respectively of the line voltage, the ratio of capacitance of the insulator to that of its capacitance to earth will be

(a) 0.25 (b) 0.5

(c) 0.65 (d) 0.75

50. While starting a synchronous motor by induction motor action, very high emf is induced in the field. This induced emf may damage the insulation of the field winding and of slip rings. The insulation damage can be prevented by

(a) short-circuiting the field winding by field discharge resistance

(b) splitting the field winding into several sections

(c) either of (a) or (b) above

(d) none of the above

SECTION - B *(Short answer type question)*
(100 Marks)

*All questions carry equal marks of **5** each.*

*This Section should be answered only on the **Answer Sheet** provided.*

1. State Nyquist stability criterion and explain the three situations while examining the stability of the linear control system.

2. Draw the schematic of load frequency control and excitation voltage regulators of a generator and explain.

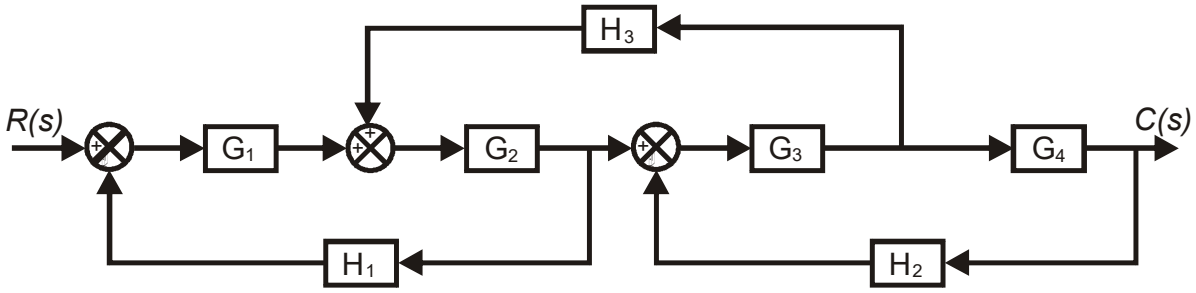
3. Drawing the circuit diagram and the phasor diagram of a synchronous motor, with resistance neglected, explain how do we get 'V' curve for constant power output.

4. With the neat block diagram explain the sampled data control system and state its advantages.

5. Describe the equal area criterion for transient stability analysis of a power system.

6. Describe the different types of excitation of DC machines. Explain the build up process of voltage of a DC shunt generator. Mention the different reasons of failure to building up process of DC shunt generator.

7. Find the transfer function of the system shown in below using signal flow graph technique.



8. Derive the relationship for fault currents in phase a and b in terms of symmetrical components when there is a double line to ground fault on phase a and b.

9. Explain the concept of alignment torque. Using this concept, discuss the condition under which reluctance torque will be developed in an electrical machine having cylindrical stator and salient pole rotor.

10. What are the different methods used for voltage control of a power system? Explain why the control of reactive power is essential for maintaining a desired voltage profile?

11. Explain in details the principle of operation of single phase inductor start induction run motor.

12. Using the Lead-Lag compensators design the control system with the following specification: phase margin $\geq$ 30 deg and step response steady-state error $\leq$ 5%.

13. Explain the function of moderator. How is a moderator selected? Why does a breeder reactor require no moderator?

14. Describe briefly the principle of operation of a polyphase induction motor. Why is a starter required in a three phase induction motor although it is self starting? What is the drawback of a DOL starter?

15. The open loop transfer function of a unity feedback system is given by $G(S) = \dfrac{K(s+9)}{s(s^2+4s+11)}$, sketch the root loci of the system.

16. State and explain whether stability limit is increased or decreased by (i) adding one or more transmission circuit in parallel and (ii) having fast acting circuit breakers.

17. Two single phase transformers in parallel supply a load of 500 amperes at 0.8 p.f. lagging and at 400 volts. Their equipment impedances referred to secondary windings are (2+j3) ohms and (2.5+j5) ohms. Compute the current and KVA supplied by each transformer and the corresponding power factor.

18. Mention the different types of inherent nonlinearities and explain dead-zone with suitable example

19. Bring out the differences and explain why dc series motor is suitable for traction over shunt motor from their speed-troque characteristics.

20. Draw the schematic diagram of a typical HVDC converter station and explain the functions of various components available.

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