MIZORAM PUBLIC SERVICE COMMISSION

COMPETITIVE EXAMINATIONS FOR JUNIOR GRADE OF M.E.S. UNDER POWER & ELECTRICITY DEPARTMENT, AUGUST, 2018.

ELECTRONICS & COMMUNICATION 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 changing electric field is equivalent to magnetic field is given by
(a) Maxwell's correction (b) Faraday's law
(c) Both (a) and (b) (d) None of these

2. The conduction current density J_C is
(a) $\frac{\partial D}{\partial t}$ (b) $\frac{\partial B}{\partial t}$
(c) $\frac{\partial E}{\partial t}$ (d) σE

3. The transformation between differential and integral form requires
(a) Stokes theorem (b) Gauss theorem
(c) Both (a) and (b) (d) None of these

4. At the interface of perfect conductor and perfect dielectric, there can exits
(a) Surface current (b) Surface charge
(c) Surface voltage (d) None of these

5. Identify the TEM wave
(a) Plane wave (b) Cylindrical wave
(c) Spherical wave (d) All of these

6. The intrinsic impedance of free space is
(a) $127\,\Omega$ (b) $177\,\Omega$
(c) $120\,\pi\Omega$ (d) $177\,\Pi\omega$

7. The propagation constant pure imaginary means
(a) Wave without attenuation (b) No wave motion
(c) Wave with attenuation (d) Wave with increasing attenuation

8. For a good conductor, the relation between α and β is
(a) $\alpha < \beta$ (b) $\alpha = \beta$
(c) $\alpha > \beta$ (d) $\alpha = (\beta/2)$

9. The phase shift constant b of the guide wave is
(a) $\beta = \sqrt{\omega^2\mu\varepsilon - \left(\frac{m\pi}{a}\right)^2}$ (b) $\beta = \omega\sqrt{\mu\varepsilon}\sqrt{1+\left(\frac{f_c}{f}\right)^2}$
(c) $\beta = \omega\sqrt{\mu\varepsilon}\sqrt{1+\left(\frac{\lambda_c}{\lambda}\right)^2}$ (d) $\beta = \sqrt{\omega^2\mu\varepsilon - \left(\frac{f_c}{a}\right)^2}$

10. The velocity of the wave is independent of frequency in case of

(a) TEM wave (b) TE wave

(c) TM wave (d) TX wave

11. The group velocity v_g is given by

(a) $v_g = \frac{c^2}{v}$ (b) $v_g = c\sqrt{1-(\frac{m\lambda}{2a})^2}$

(c) $v_g = c\sqrt{1+(\frac{m\lambda}{2a})^2}$ (d) $v_g = \frac{c^2}{v^2}$

12. The power loss in plane conductor is

(a) $R_s K_{eff}^{\ 2}$ (b) $R_s J_{eff}^{\ 2}$

(c) $R_s I_{eff}^{\ 2}$ (d) $R_s V_{eff}^{\ 2}$

13. For lossless line

(a) $\alpha = 0,\ \beta = 0$ (b) $\alpha = 0,\ \beta \neq 0$

(c) $\alpha \neq 0,\ \beta = 0$ (d) $\alpha \neq 0,\ \beta \neq 0$

14. The line impedance at voltage minimum is

(a) Resistive (b) Capacitive

(c) Inductive (d) Complex

15. The reflection coefficient over the normalized load Z_L is

(a) $\frac{(Z_L - 1)}{(Z_L + 1)}$ (b) $\frac{(Z_L + 1)}{(Z_L - 1)}$

(c) $\frac{(Z_S - 1)}{(Z_S + 1)}$ (d) $\frac{(Z_S + 1)}{(Z_S - 1)}$

16. The range of SWR is

(a) (-1) to (+1) through 0 (b) (+1) to infinity

(c) 0 to infinity (d) (-1) to infinity

17. For a common-base BJT configuration having $I_e = 5$ mA and $\alpha = 0.97$, an AC signal of 5 mV is applied between the base and emitter terminals. What is the value of output impedance and current gain?

(a) 0, 0.97 (b) ∞, 0.97

(c) ∞, -0.97 (d) 0, -0.97

18. The current gain of BJT is

(a) $g_m r_0$ (b) g_m / r_0

(c) $g_m r_\pi$ (d) g_m / r_π

19. It is required to deliver an output DC power of 500 W to a resistive load. The transformer rating required in case of half-wave, conventional full-wave and bridge rectifiers, respectively, is

(a) 1.7 kW, 616 W, 871 W (b) 1.7 kW, 871 W, 616 W

(c) 616 kW, 1.7 W, 871 W (d) 871 kW, 616 W, 1.7 W

20. For a transistor amplifier to be inherently stable against thermal runaway, the condition is

(a) $V_{CE} < (V_{CC}/2)$ (b) $V_{CE} > (V_{CC}/2)$

(c) $V_{CE} = (V_{CC}/2)$ (d) None of these

21. Negative feedback in an amplifier

(a) Reduces bandwidth (b) Increases frequency and phase distortions

(c) Reduces gain (d) Increases noise

22. What is the percentage reduction in gain of an amplifier due to introduction of 20 dB of negative feedback?

(a) 100% (b) 50%

(c) 90% (d) 70%

23. The bandwidth of a single-stage amplifier extends from 10 Hz to 100 KHz. What is the lower cut-off frequency where the voltage gain is down by 1 dB from its mid-band value?

(a) 20.5 Hz (b) 10 Hz

(c) 4.5 Hz (d) 19.65 Hz

24. An op-amp having a slew-rate specification of 1 V/μs has been connected in the voltage follower configuration. The input is a unit step of voltage applied at instant t = 0. What is the output magnitude at t = 500 ns?

(a) 1 V (b) 0 V

(c) 0.5 V (d) 2.5 V

25. Given an op-amp with output saturation voltages of ± 10 V and slew rate of 10 V/μs. What is the highest input frequency that would yield output waveform transition time of not more than 10% of half of the time period of input signal?

(a) 1 KHz (b) 10 KHz

(c) 25 KHz (d) 100KHz

26. A biasing circuit has a stability factor of 40. If due to temperature change, I_{co} changes by 1μA, then I_c will change by

(a) 20 μA (b) 40 μA

(c) 80 μA (d) None of these

27. In class A amplifier $V_{CE\ max}$=15 V and $V_{CE\ min}$=1V. The conversion efficiency for a series fed load will be equal to

(a) 25% (b) 23.33%

(c) 12.5% (d) 11.67%

28. Negative feedback in an amplifier leads to which one of the following

(a) Decrease in bandwidth (b) Increase in voltage gain

(c) Increase in current gain (d) Decrease in voltage gain

29. Virtual ground in an OP-AMP is due to

(a) High gain (b) High input impedance

(c) Both high gain and high input impedance (d) Terminal is directly connected to ground.

30. The complement of $[(A\overline{B}+\overline{C})D+\overline{E}]F$ is

(a) $[(\overline{A}+B).C+\overline{D}].E+\overline{F}$ (b) $[(\overline{A}+B).C+\overline{D}]+\overline{F}$

(c) $[\overline{A}+B+\overline{D}].E+\overline{F}$ (d) $[(\overline{A}+B).C+\overline{D}].E+F$

31. If $f(A,B,C)=\sum 1,2,3,4,5,6,7$ and there are no 'don't care' entries, then $f'(A,B,C)$ is equal to

(a) $\left[\overline{A}+\overline{B}+\overline{C}\right]$ (b) A+B+C

(c) $\overline{A}\cdot\overline{B}\cdot\overline{C}$ (d) $A\cdot B\cdot C$

32. The unused inputs of CMOS logic family should never be left open. They should

(a) Preferably be grounded

(b) Preferably be tied to $+V_{DD}$

(c) Be tied to logic LOW or logic HIGH level or another used input.

(d) Preferably be connected to one of the used inputs

33. Two binary digits are applied to the inputs of a two-input AND gate. The output of the logic can generate

(a) BORROW OUT of a half subtractor
(b) CARRY OUT of a half-adder
(c) SUM output of a half-adder
(d) DIFFERENCE output of a half-adder

34. The size of PROM needed to implement a dual 8-to-1 multiplexer with common selection inputs would be

(a) 256 K x 2
(b) 512 K x 2
(c) 1024 K x 2
(d) None of these

35. The 10-input bits to a 10-line decimal to four-line BCD priority encoder corresponding to 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9, respectively, are 1, 0, 0, 0, 1, 1, 0, 1, 0 and 0. What will be the corresponding BCD output if all inputs and outputs are active HIGH? The encoder has priority for higher order bits.

(a) 0111
(b) 1000
(c) 1001
(d) 0110

36. The minimum number of 2-to -1 multiplexers required to generate a two-input AND gate and a two-input EX-OR gate

(a) 1 and 2
(b) 1 and 3
(c) 1 and 1
(d) 2 and 2

37. There is a negative edge-triggered R-S flip-flop having active-LOW R and S inputs and active-HIGH outputs. Identify the forbidden input entry

(a) R = 0, S = 1
(b) R = 0, S = 0
(c) R = 1, S = 1
(d) R = 1, S = 0

38. For one of the following conditions, clocked J-K flip-flop can be used as a divide-by-1 circuit when the input is applied at clock input.

(a) J = K = 1 and flip-flop has active HIGH inputs
(b) J = K = 0 and flip-flop has active HIGH inputs
(c) J = K = 1 and flip-flop has active LOW inputs
(d) J = 0, K = 1 and flip-flop has active HIGH inputs

39. The counter that has a modulus of 64 should use a minimum of

(a) Six flip-flops
(b) Six J-K flip-flops
(c) Six D- flip-flops
(d) 64 T flip-flops

40. A four-bit ripple counter and a four-bit synchronous counter are made using flip-flops having a propagation delay of 10 ns each. If the worst case delay in the ripple counter and the synchronous counter be R and S respectively, then

(a) R = 10 ns and S = 40 ns
(b) R = 40 ns and S = 10 ns
(c) R = 10 ns and S = 30 ns
(d) R = 30 ns and S = 40 ns

41. Among the following types of A/D converters, name the one which the analog signal is sampled at a frequency much higher than the Nyquist rate

(a) Tracking type A/D converter
(b) Dual-slope integrating-type A/D converter
(c) Half-flash A/D converter
(d) Sigma-Delta A/D converter

42. The minimum number of comparators required to build an eight-bit-flash ADC is

(a) 8
(b) 63
(c) 255
(d) 290

43. A certain control system is represented by the following differential equation. Its transfer function would be $\frac{d^2y}{dt^2}+\frac{dy}{dt}+3y=\frac{dx}{dt}+2x$

(a) $\frac{s+2}{s+3}$ (b) $\frac{s+2}{s^2+s+3}$

(c) $\frac{s^2+2}{s^2+s+3}$ (d) None of these

44. The open-loop transfer function of a unity feedback system is $G(s)=\frac{K}{s(s^2+s+2)(s+3)}$. The range of K for which the system is stable is

(a) $\frac{24}{4}>K>0$ (b) $13>K>0$

(c) $\frac{21}{4}<K<\infty$ (d) $-6<K<\infty$

45. For a feedback control system, G(s) = $\frac{20}{s^2}$ and H(s) = (s+3). The stedy-state output for a unit step input will be

(a) 1 (b) 0.5

(c) 0 (d) 0.33

46. A lead compansator may be represnted by one of the following transfer functions.

(a) $\frac{s+2}{s+4}$ (b) $\frac{s+4}{s+2}$

(c) $\frac{s(s+2)}{s+4}$ (d) $\frac{s+2}{s(s+3)}$

47. The open-loop frequency response of a system at two particular frequencies are given by $1.2\angle -180°$ and $1.0\angle -190°$. The closed-loop unity feedback control is then

(a) Stable (b) Unstable

(c) Marginally stable (d) None of these

48. In the Bode-plot of a unity feedback control system, the value of hase of G(jω) at the gain cross over frequncy is -125^0. The phase margin of the system is

(a) -125^0 (b) -55^0

(c) 55^0 (d) 125^0

49. The Nyquist plot of G(jω) H(jω) for a closed-loop control system, passed through (-1, j0) point in the GH plane. The gain margin of the system in dB is equal to

(a) Infinite (b) Greater than zero

(c) Less than zero (d) Zero

50. The impulse response of a certain system is Sin2t. The system transfer function is

(a) $\frac{1}{s^2+2}$ (b) $\frac{2}{s^2+2}$

(c) $\frac{2}{s^2+4}$ (d) $\frac{s}{s^2+4}$

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. In a three dimensional space divided into region $1(x \lhd 0)$ and region $2(x \rhd 0)$, $\sigma_1 = \sigma_2 = 0$, $\overline{E}_1 = 1\hat{a}_x + 2\hat{a}_y + 3\hat{a}_z$, $\varepsilon_{r1} = 1$ and $\varepsilon_{r2} = 2$. Find the value of E_2.

2. State Gauss's law and establish the relation $\nabla.\overline{D} = \rho_v$ where symbols are of usual meaning.

3. A lossy dielectric has the intrinsic impedance of 200 e^{j30} ohm at a particular frequency. If at that frequency the plane wave propagating through the dielectric has the magnetic field component $\overline{H} = 10e^{-\alpha x}\cos(\overline{\omega t} - \frac{x}{2})\overline{a_y}$ A/m. Find $\overline{E}$ and α. (Symbols are of usual meanings)

4. A TEM wave passing through a medium with intrinsic impedance of 200 Ω is falling normally on a medium with intrinsic impedance of 400 Ω. Find SWR of the first medium and the phase difference between reflected and incident electric field.

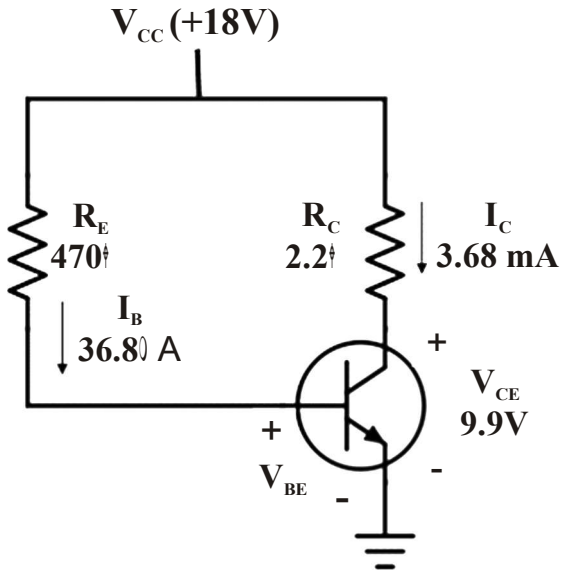
5. Find out directivity of a source with radiation intensity $U = U_m \sin^2\theta$; where U_m is the peak radiation intensity.

6. Derive the expression for the input impedance Z_{in} of a lossless transmission line in terms of relevant parameters, when the line is terminated into impedance Z_L.

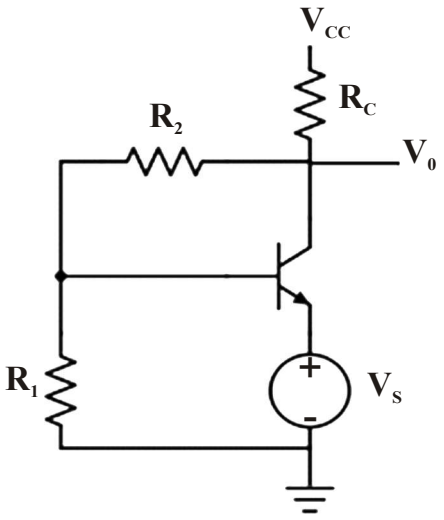
7. Discuss the effect of stray capacitance at the input terminals of an operational amplifier. Explain the precautions that should be observed to deal with input stray capacitance problem.

8. Prove that the amplifier gain in a phase shift oscillator is at least 29 for sustained oscillation.

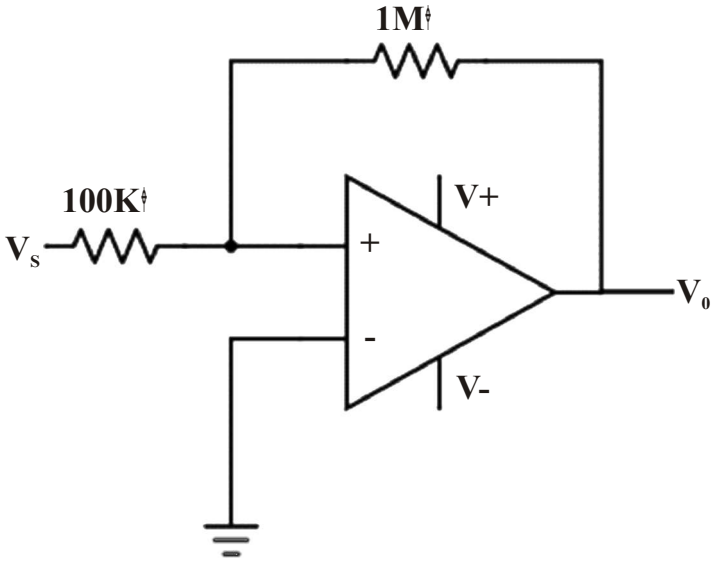
9. Calculate the maximum and minimum levels of I_C and V_{CE} for the base bias circuit shown below when $h_{FE}(min) = 50$ and $h_{FE}(max) = 200$.



10. Calculate A_{vf} for the circuit shown below, which has a voltage-series feedback network.



11. Determine the transimpedance gain, the input impedance and output impedance of the amplifier shown below. Given that transimpedance, input impedance and output impedance parameters of the op-amp are $100\text{M}\Omega$, $10\text{M}\Omega$ and $100\,\Omega$ respectively.



12. Express the Boolean function $F = A + \overline{B}C$ as a sum of minterms.

13. Prove that

$$A \cdot B \cdot C \cdot D + A \cdot B \cdot \overline{C} \cdot \overline{D} + A \cdot B \cdot C \cdot \overline{D} + A \cdot B \cdot \overline{C} \cdot D + A \cdot B \cdot C \cdot D \cdot E + A \cdot B \cdot \overline{C} \cdot \overline{D} \cdot \overline{E} + A \cdot B \cdot \overline{C} \cdot D \cdot E = A \cdot B$$

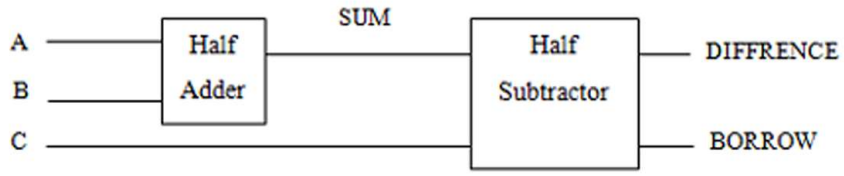
14. Minimize the Boolean function using Karnaugh map in both sum-of-products and product-of-sums forms.

$$f(A,B,C) = \sum 0,1,3,5 + \sum_{\varnothing} 2,7$$

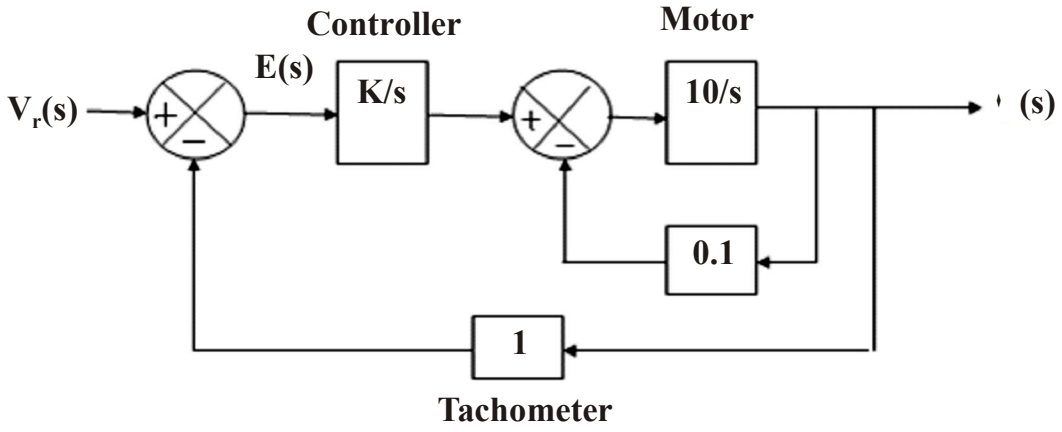
15. Implement the following Boolean function using NAND gates $f(x,y,z) = (1,2,3,4,5,7)$

16. Construct a JK flip-flop using a D flip-flop, a 2-to-1 line multiplexer and an inverter.

17. Write the simplified Boolean expression for DIFFERENCE and BORROW of the following figure.



18. Consider the speed control system shown in figure wherein the inner loop corresponds to motor back emf. The controller is an integrater with gain K observed that the load is inertia only. Determine the value of K for which steady-state error to unit ramp input $\left[V_r(s)=\frac{1}{s^2}\right]$ is less than 0.01 rad/sec.



19. A unity negetive feed back system has open-loop transfer function $G(s)=\frac{K}{s(s+2)}$. Calculate the value of gain K so that the closed-loop system has a steady-state unit ramp error of 0.1, Find corresponding damping factor and percentage peak overshoot to unit step input.

20. The close loop transfer function of a unity feedback control system is given by $\frac{C(s)}{R(s)}=\frac{Ks+\beta}{s^2+\alpha s+\beta}$

Show that its steady state error for unit ramp input is $(\alpha-K)/\beta$.

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