APSPDCL-2012 Solutions:

(1) **C**

$W_1 = VI\cos(30-\phi)$–High reading watt meter

$W_2 = VI\cos(30+\phi)$–Low reading watt meter

Given $\cos\phi = 0.5 \Rightarrow \phi = \cos^{-1}(0.5) = 60^o$

$W_1 = VI\cos(30-60)$

$W_2 = VI\cos(30+60) = VI\cos 90^o = 0$ W

So, total power is measured by one wattmeter method.

(2) **D**

Given reactive power measured by wattmeter is zero. This means that the circuit is purely resistive, so the p.f of circuit will be unity.

(3) **C**

For maximum power transfer, source resistance is equal to the equivalent resistance of combined load.

Since $R_s = 2\ \Omega$ and to get $2\ \Omega$ in load a parallel resistance of another $4\ \Omega$ should be connected.

(4) **B**

Given,

$i(t) = 4\sin(500t)$ from which $\omega = 500 \Rightarrow f = 250/\pi$, L = 20 mH

$\Rightarrow X_L = 2\pi \times \frac{250}{\pi} \times 20 \times 10^{-3} = 10\ \Omega.$

$\therefore Z = 10 + j10 = 10\sqrt{2}\angle 45^0$

$v(t) = i(t).Z$

$= 4\sin(500t+0^0) \times 10\sqrt{2}\angle 45^o$

$= 56.56\sin(500t+45^o).$

(5) **A**

Open circuit impedance parameters of a two port network are given by

$V_1 = Z_{11}I_1 + Z_{12}I_2$

$V_2 = Z_{21}I_1 + Z_{22}I_2$

Hence V_1 and V_2 are expressed in terms of I_1 and I_2.

(6) **B**

For series connection of two 2-port networks Z-parameters, for parallel Y-parameters and for cascade connection ABCD parameters are convenient to use.

(7) **B**

$Q = X_L/R \Rightarrow Q \propto X_L$

But $X_L \propto \frac{1}{\cos\phi}$, $\therefore Q \propto \frac{1}{\cos\phi}$. Hence on increasing Q factor of a coil, its power factor decreases.

(8) **A**

The impedance offered by a series RLC circuit at resonance is equal to the resistance of the circuit. So at resonance, by varying R, current can be varied.

(9) **B**

The equivalent inductance,

L_{eq} = (2+2)//4 = 4//4 = 2H.

(10) **D**

A charged capacitor acts as a voltage source.

(11) **B**

An electric network with eight independent nodes will have eight nodal equations.

(12) **D**

$Z_1/Z_2 = 20\angle 50^0 / 10\angle 30^0 = 2\angle 20^0$.

(13) **D**

Instrument transformers are particularly used for measuring high voltage and high currents.

(14) **B**

Swamping resistance is a resistor with zero temperature co-efficient and connected in series with the meter movement in an ammeter circuit.

(15) **C**

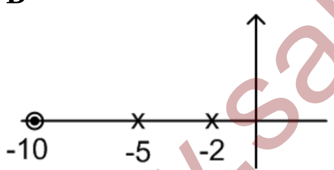
The power in a 3-phase circuit is given by $P = \sqrt{3} V_L I_L \cos\phi$. For measuring $\cos\phi$, P, V_L and I_L are required.

(16) **C**

Schering bridge is used for measuring capacitance, dielectric loss etc.

(17) **C**

(18) **D**



Given, $G(s)\,H(s) = \frac{K(s+10)}{(s+2)(s+5)}$

The breakaway point lies between -2 and -5.

(19) **C**

P = 12 and Z = 2

For 12 poles slope = 12 × -20dB = -240 dB

For 2 zeros slope = 2 × +20 dB = +40 dB

The resultant slope of asymptote = -240+40 = -200 dB/dec.

(20) **A**

Gain margin = $\frac{1}{0.2}$ = 5.

(21) B

Since, gain margin $\propto \frac{1}{\text{open loop gain}}$.

(22) B

$G(s) = \frac{4(1+0.15s)}{(1+0.05s)}$, it is in the time constant form $\frac{1+\tau s}{1+\tau\alpha s}$

where $\tau = 0.15$ and $\alpha\tau = 0.05$

$\alpha = \frac{0.05}{0.15} = \frac{1}{3}$

The maximum phase shift,

$\theta = \sin^{-1}\left(\frac{1-\alpha}{1+\alpha}\right) = \sin^{-1}\left(\frac{1-\frac{1}{3}}{1+\frac{1}{3}}\right) \Rightarrow \theta = \sin^{-1}(1/2) = 30^o$.

(23) B

Given,

$T = 100$ ms, $R_A = 100$ kΩ. In monostable multivibrator using 555 timer, the value of timing resistor is given by

$R_A = \frac{T}{1.1C} \Rightarrow T = 1.1R_AC$

$C = \frac{100\times10^{-3}}{1.1\times100\times10^{3}} = 0.9\times10^{-6}F = 0.9\ \mu F$.

(24) C

For an ideal op amp $R_i = \infty$, $R_o = 0$,

$A = \infty$, CMMR $= \infty$.

(25) D

LM stands for national semiconductor.

(26) D

For digital panel meters and multi meters accuracy is more important. So, dual slope ADC is preferred.

(27) C

Slew rate $= \frac{dV_o}{dt}$

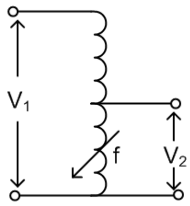
Maximum change in output voltage = 6 V. Change in time = 0.5/2 = 0.25μs

$\therefore$Slew rate $= \frac{6}{\frac{0.5}{2}} = 24$ V/μs.

(28) C

Damper bars are used in salient pole synchronous machines for starting and to reduce hunting. In squirrel cage machines, rotor bars are used. Commutator is used in DC machine for converting AC into DC and vice versa.

(29) C



In auto transformer there is direct connection between primary and secondary windings.

When there is a fault in the secondary, the total primary voltage will appear across secondary windings. This is one of the serious disadvantage of an auto transformer.

(30) A

Rated secondary current/ph = $\frac{P}{\sqrt{3}V} = \frac{230\times1000}{\sqrt{3}\times2300}$ = 33.33A.

(31) B

For induction motors under normal running conditions slip varies from 1 to 0. When the machine is running in counter clockwise direction with reverse phase sequence of supply, slip varies from 1 to 2.

(32) C

Injected e.m.f E_j, is out of phase with slip e.m.f SE_2. So, motor runs below synchronous speed. However, the phase angle β is reduced. So the rotor PF is increased.

(33) C

For cylindrical pole synchronous machines $\delta_{max} = 90^o$.

For salient pole synchronous machines $\delta_{max} < 90^o$

(34) A

$P_{max} = \frac{V^2}{X_S}$; at K_f and K_V $\frac{K^2V^2}{2\pi KfL}$ =

K .$\frac{V^2}{X_S}$; P_{max} is K times reduced.

(35) D

During hunting, speed varies between above and below the synchronous speed of RMF. When speed is super synchronous damper bar develops induction generator torque and when speed is sub synchronous, it develops induction motor torque.

(36) D

Bi-directional voltage control is possible with DIAC-TRIAC phase control circuit.

(37) C

Illumination=candle power/(distance)^2

$d^2 = 30/50 = 2 \Rightarrow d = \sqrt{2} = 1.414$.

(38) D

Luminous intensity of a lamp = flux/2π. Flux = $2\pi \times 750 = 1500\pi$.

(39) A

For electrical cremation, resistance heating is used.

(40) **A**

Least radiant heat is produced by fluorescent lamps.

(41) **A**

Track friction $\propto \frac{1}{\text{speed}}$.

(42) **D**

$a = -0.5 + j0.866;\ a^2 = -0.5 - j0.866$

$1 + a - a^2 = 1 - 0.5 + j0.866 + 0.5 + j0.866 = 1 + j\sqrt{3} = 2\angle 60°$

(43) **D**

No of strands on a n-layer cable is given by $3n^2 - 3n + 1$.If $n = 3$,

$3 \times 3^2 - 3 \times 3 + 1 = 27 - 9 + 1 = 19.$

(44) **A**

Maximum power transmitted through line = P_{max}, 60% of series capacitor compensation reduces the % reactance of line to 40%.

$P_{max1} = \frac{EV}{X_1}$; $P_{max2} = \frac{EV}{0.4X_1} = 1/0.4 \times \frac{EV}{X_1} = P_{max1}/0.4$.

(45) **C**

(46) **B**

Daily load factor = $\frac{1500 \times 12\text{hrs} + 1000 \times 12\text{hrs}}{1500 \times 24\text{ hrs}}$ = 0.833.

(47) **C**

Extra series reactance to be connected $= \frac{1}{5} - \frac{1}{8} = 0.075$ p.u.

(48) **B**

Merz-Price protection scheme is more suitable for generators.

(49) **C**

DC series motor is a variable speed motor. For low T_L its speed is very high and for increased T_L, speed is reduced.

(50) **C**

Due to sag, between two supports, the conductor takes the shape of catenary. If sag is small compared to span, then the shape of conductor is parabola.

(51) **C**

Lowest disc is nearest to the conductor. So the potential drop across it is maximum.

(52) **B**

During humid weather ion concentration in air will increases. This reduces the critical distruptive voltage for corona.

(53) C

Equal area criterion can be applied to single machine connected to infinite bar system.

(54) A

An ideal current source has infinite internal resistance or zero conductance.
An ideal voltage source has zero internal resistance or infinite internal conductance.

(55) D

From figure,

$R_1 = \frac{1\times2}{1+2+3} = 1/3\ \Omega;$

$R_2 = \frac{1\times3}{1+2+3} = \frac{1}{2}\ \Omega;$

$R_3 = \frac{3\times2}{1+2+3} = 1\ \Omega.$

∴The highest value of resistance is 1 Ω.

(56) A

Super position theorem is applied by considering only one source at a time.

(57) B

The given circuit has star and mesh connections.

(58) B

At half power frequencies, the current in an RLC series circuit is $1/\sqrt{2} \times (0.707)$ of its value at resonance.

(59) B

In a series RLC resonant circuit, inductive and capacitive reactances cancel out each other. So, the impedance at resonance will be minimum and the current through circuit will be maximum. In parallel RLC resonant circuit, the impedance will be maximum and hence will be minimum.

(60) C

The two coils are in parallel opposing.

(61) A

Given V = 220V and $f = 100/2\pi$ Hz,

R = 100Ω, L = 1H.

$X_L = 2\pi fL = 2\pi \times 100/2\pi \times 1 = 100\ \Omega$

$Z = R + jX_L = 100 + j100$

$|Z| = \sqrt{100^2 + 100^2} = 100\sqrt{2}\ \Omega$

$V_L = V \times X_L/|Z| = 220 \times 100/100\sqrt{2} = 220/\sqrt{2}.$

(62) D

For an initially relaxed series R-C circuit when DC supply is suddenly applied, the capacitor acts as a short circuit. Under steady state conditions, the capacitor acts like an open circuit.

(63) **D**

(64) **C**

$V_S = \sqrt{V_R^2 + V_L^2} \Rightarrow V_R = \sqrt{V_s^2 - V_L^2}$

$= \sqrt{10^2 - 8^2} = 6V.$

Current through 1 Ω resistor = V_R/R = 6/1 = 6 A.

(65) **A**

Conductance is the reciprocal of resistance.
Admittance is the reciprocal of impedance.
Susceptance is the reciprocal of reactance.

(66) **D**

$P = \sqrt{3}V_L I_L \cos\phi = 3V_L I_L \cos\phi$

In both the cases ϕ is the angle between phase voltage and phase current.

(67) **C**

$G(s) = \frac{K}{s(s+1)}$ and

C.L.T.F = $\frac{\frac{K}{s(s+1)}}{1+\frac{K}{s(s+1)}} = \frac{K}{s(s+1)+K}$

Comparing it with standard second order system

$2\xi\omega_n = 1 \Rightarrow \xi = 1/2\sqrt{K}$

If $K = \infty$ then $\xi = 0$.

(68) **D**

G_1 and G_2 blocks are added and G_3 and G_4 blocks are added. Now, the overall transfer function will be $(G_1 + G_2) \times (G_3 + G_4)$.

(69) **A**

Open loop systems are highly stable.

(70) **A**

Using R-H criterion,

S^4	1	1	5
S^3	2K	5	0
S^2	$\frac{2K-5}{2K}$	5	0
S^1	$\frac{5(\frac{2K-5}{2K})-10K}{2K}$		
S^0			

$2K > 0 \Rightarrow K > 0$

$\frac{2K-5}{2K} > 0 \Rightarrow 2K > 5 \Rightarrow K > 5/2$

$5(\frac{2K-5}{2K}) > 10K \Rightarrow 10K\text{-}25 > 20K^2$

$\Rightarrow -20K^2+10K-25 > 0$

$20K^2-10K+25 > 0 \Rightarrow 4K^2-2K+5 > 0$

(71) **A**

If the gain of an unstable system is decreased, it becomes stable.

(72) **A**

Applying KVL to the input loop,

$V_{CC} = I_B R_B + V_{BE} + R_E I_E$

$= I_B R_B + V_{BE} + R_E(1+\beta) I_B$

$\therefore 20 = I_B.430k + 0.7 + 1k(1+100) I_B$

$20-0.7 = I_B(430k+101k)$

$I_B = \frac{19.3}{531k} = 36.35$ mA.

(73) **B**

Given, $V_P = -3$ V, $I_{DSS} = 9$ mA, $V_{GS} = 0$ V

Transconductance, $g_{m0} = \frac{-2I_{DSS}}{V_P} = \frac{-2\times9\times10^{-3}}{-3} = 6$ mS.

(74) **C**

Given, $V_{CC} = 24V$, $V_{p\text{-}p} = 6V$

Efficiency $\eta = 78.6 \times V_{p\text{-}p}/V_{CC}$

$= 78.6 \times 6/24 = 19.6\%$.

(75) **B**

Given, C = 100µF, $I_{DC} = 50mA$

(76) **D**

The free running frequency of a 565 PLL is given by

$f_0 = \frac{1.2}{4R_1C_1} = \frac{1.2}{4\times10\times10^3\times200\times10^{-12}} = 150$ kHz.

(77) **A**

When a D.C motor is operating under constant power output mode,

$T \alpha I_f$

(78) **B**

Given P = 2, wave connected. So no of parallel paths, A = 2

No of conductors/parallel path = 120

Total no of conductors, Z=120×2=240

Speed, N = 1200 rpm

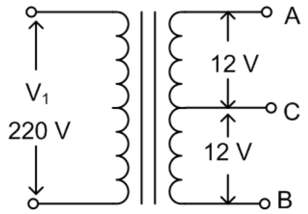
Flux/pole, $\phi = 0.02$ wb/pole

Induced emf, $E_g = \frac{\phi NZ}{60} \times \frac{P}{A} = \frac{0.02 \times 240 \times 1200}{60} \times \frac{2}{2} = 96$ V.

(79) **B**

For a separately excited generator, when speed is zero, the open circuit voltage is also zero. So 4 and 3 are wrong. If I_f is kept constant and speed is varied, the variation in induced e.m.f cannot be linear. Hence 1 is wrong. Up to critical speed, the increase in induced e.m.f is small.

(80) **D**



Given,

V_1 = 220V and V_2 = 12-0-12. There is a midpoint tapping on secondary side. Also e.m.f/turn = 1V. For a transformer, e.m.f/turn is same on both the primary and secondary windings.

For AC to be get 12V, N_1 = emf/turn × 12 = 12 V

For BC to be get 12V, N_2 = emf/turn × 12 = 12 V

∴Total turns on secondary = N_1+N_2 = 24 with center tapped.

(81) **D**

Given that,

$N_1 = 100$, $N_2 = 100$, $\phi_m(t) = -0.05(t^2-2t)$

Induced e.m.f of secondary

$= N_2 \times \frac{d}{dt}\phi_m(t) = 200 \times \frac{d}{dt}[-0.05(t^2-2t)] = 200 \times -0.05(2t-2) = -20 \times (t-1)$.

(82) **A**

Since N and S poles are at 1 and 1' e.m.fs are induced in them. By using Fleming's right hand rule the direction of currents can be determined.

(83) **D**

Given, X_S = 1p.u, V_t = 1p.u, E = 1.5p.u, $\delta = 0^0$electrical, I_a = 0+j0.5.

(84) **B**

Given, P = 16, 3-phase, S = 108, Phase spread = 60^0. 3,2,2,2 coils in basic unit of 4 poles.

(85) **B**

Given that,

f = 1KHz, T_{ON} = 0.5ms.

T = 1/f = 1ms.

So, SCR turn-on for 0.5 ms and turn-off time for 0.5 ms. Hence the average voltage across motor terminals will be 100 V. Since T_m = constant $\propto E_b \propto V$. ∴ N = 500 rpm.

(86) **C**

The polarities at the motor terminals

are reversed. This is plugging.

(87) **C**

The output of -ϕ inverter bridge for 120^0 conduction mode is given. Therefore 3^{rd} and triplen harmonics in the output voltage are absent.

(88) **B**

Given, P = 16, 500MVA, 22KV, angular acceleration = 437.8 electrical degrees.

Angular velocity in mechanical degrees/sec = 437.8/pair of poles = 437.8/2 = 218.9 mech.deg/sec.

So $\omega = 2\pi N/60 \Rightarrow (2\times180\times N)/60 = 218.9$.N in rpm/sec = 36.48rpm/sec.

(89) **C**

Given, f = 50 Hz, H_G = 6 MJ/MVA,

H_M = 6 MJ/MVA, P_g = 1p.u,

$P_{g\ fault}$ = 0.6 p.u

(90) **B**

Synchronizing power coefficient, $P_{syn} = P_{max}.\cos\delta$.

(91) **A**

(92) **C**

Given 1500 A, 2000 MVA, 33 kV rated OCB

Making current = $2.55 \times \frac{2000\times10^6}{\sqrt{3}\times33\times10^3}$ = 89.2 kA.

(93) **C**

(94) **B**

Reserve capacity = Plant capacity – Maximum demand.

Plant capacity = $\frac{\text{Average demand}}{\text{Plant capacity factor}}$

Average demand = Load factor × Maximum demand.

= 0.6 × 30 = 1.8MW

Plant capacity = $\frac{1.8}{0.48}$ = 37.5MW.

Reserve capacity = 37.5 – 30 = 7.5MW.

(95) **B**

$Z_{new} = Z_{old}\times(\frac{MVA_{new}}{MVA_{old}}) \times (\frac{KV_{old}}{KV_{new}})^2 = 0.1 \times (20/10) \times (33/22)^2 = 1.8$ p.u.

(96) **A**

Zero sequence currents will be absent

when there is no involvement of ground.

(97) **A**

Given that,

V = 1.5p.u , X_S = 1 p.u , X_l = 0.3 p.u. Maximum steady state power transfer,

$P = \frac{V}{X_S + X_l} = \frac{1.5}{1.3} = 1.154$ p.u.

(98) **D**

(99) **B**

Step1: j0.08 is connected between node1 and reference node

$Z_{bus} = [j0.08]$

Step2: j0.5 is connected between node1 and node2.

$$Z_{bus} = \begin{bmatrix} j0.08 & j0.08 \\ j0.08 & j0.58 \end{bmatrix}$$

(100) **A**

Relay current setting = 125%

C.T ratio = 400/5 = 80

pick up value = 1.25×5 = 6.25A.