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SCHEME OF VALUATION

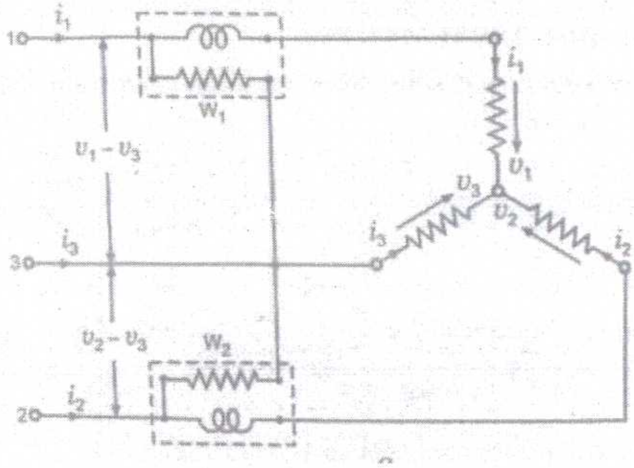
Scoring Indicators

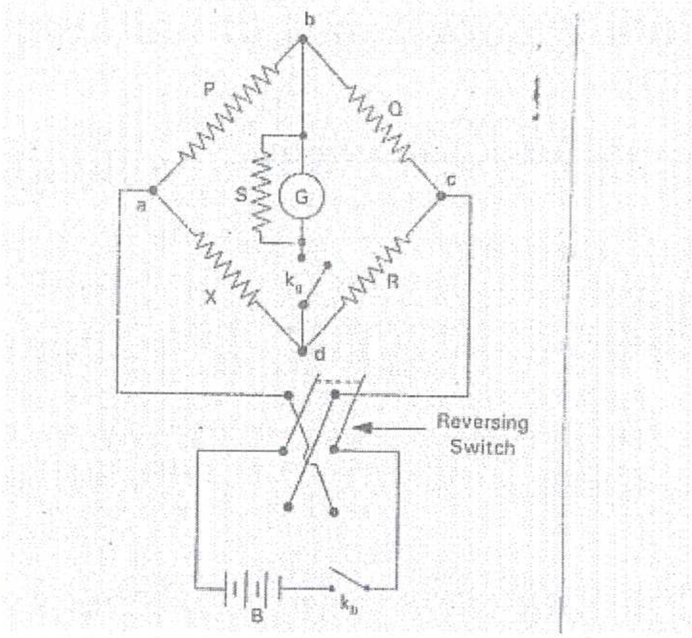
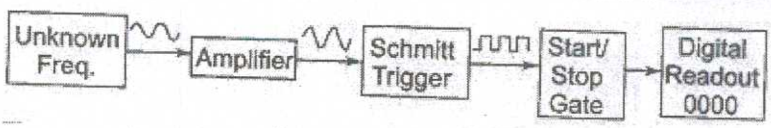
Revision: 2015 Course code: 3032

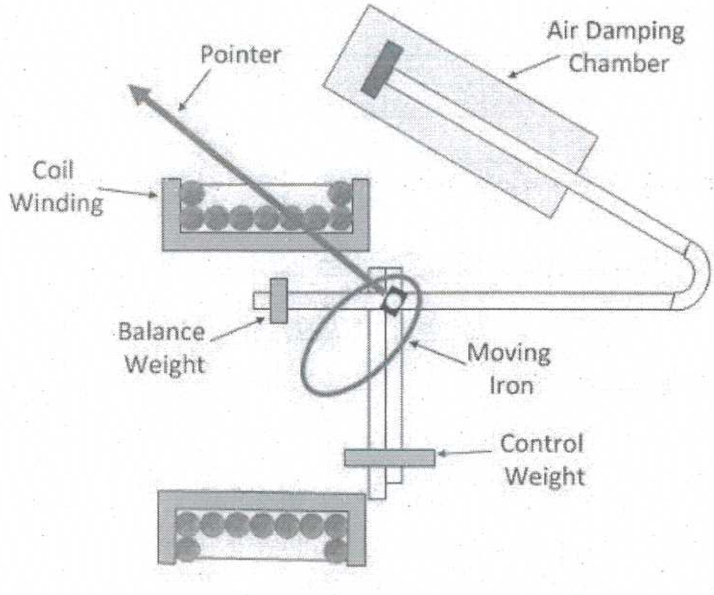
Course Title: **ELECTRICAL MEASURING INSRUMENTS**

Qst No.	Scoring indicator	Split up score	Subtotal	Total
I.1.	Eddy current damping	2	2	2
I.2.	CRO	2	2	2
I.3.	Multiplication factor= $\frac{Selected\ voltage\ range \times Selected\ current\ range \times pf}{Full\ scale\ deflection}$	2	2	2
I.4.	(i).Low resistance-Resistance whose values are between 1Ω and 10Ω (ii).Medium resistance- Resistance whose values are between 10Ω and 100 kΩ (iii).High resistance- Resistance whose values are beyond 100 kΩ.	1 1	2	2
I.5.	Used to determine the phase sequence(RYB or RBY)	2	2	2
II.1				

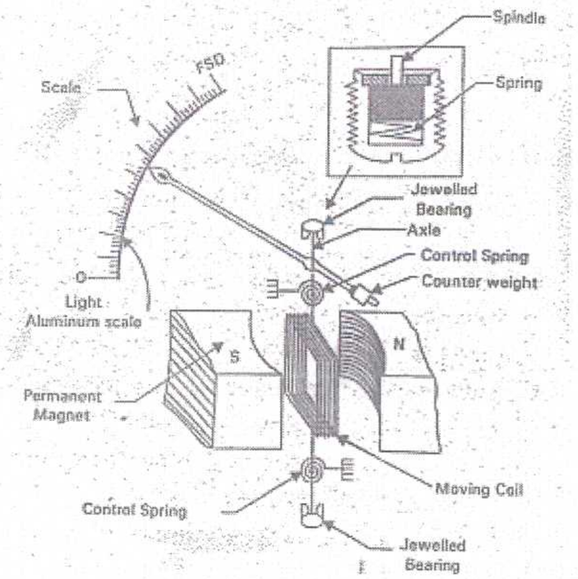
M.I Instruments	M.C Instruments	Split up score	Subtotal	Total
It can be used for a.c as well as d.c voltage and current measurement.	It is suitable only for the d.c voltage and current measurement.	1		
Less sensitive as compared to MC instruments.	It is much sensitive than M.I instruments.	1		
Torque to weight ratio is less as compared to M.C type.	Torque to weight ratio is high as compared to M.I type.	1		
It is cheaper then MC and dynamometer.	It is costlier then M.I and dynamometer type due to high cost of permanent magnets.	1		
Air friction damping is used.	Damping is perfect as eddy current damping is used.	1		
Error are set due to hysteresis and stray fields.	Error are set due to aging of control springs,permanent magnet.	1	6	6

<table>
<tr><td>II.2</td><td>
</td><td>6</td><td>6</td><td>6</td></tr>
<tr><td>II.3</td><td>Creeping in energy meter is the **phenomenon** in which the aluminium **disc rotates** continuously when only the **voltage** is **supplied** to the **pressure coil,** and **no current** flows through the **current coil**.
Causes:
• Over compensation of frictional error.
• Mechanical vibration.
• Stray magnetic field.
Remedies:
• Drilling diametrically opposite holes on the aluminium disc. The aluminium disc stops rotating even when the small edge of the disc come under the pole of the magnet. The holes will limit the revolution of the disc.
• A small piece of iron is attached to the edge of the disc. The force of attraction occurs between the pole magnets and the iron piece, which prevent the creeping of the disc.</td><td>2
2
2</td><td>6</td><td>6</td></tr>
<tr><td>II.4</td><td>P & Q are fixed resistance and form ratio arm, R is known resistance and X is un known resistance. At balance, $i_1P = i_2X$ & $i_1Q = i_2R$
$\Rightarrow \frac{P}{Q} = \frac{X}{R} \quad \Rightarrow X = \frac{P}{Q}R$</td><td>3</td><td></td><td></td></tr>
</table>

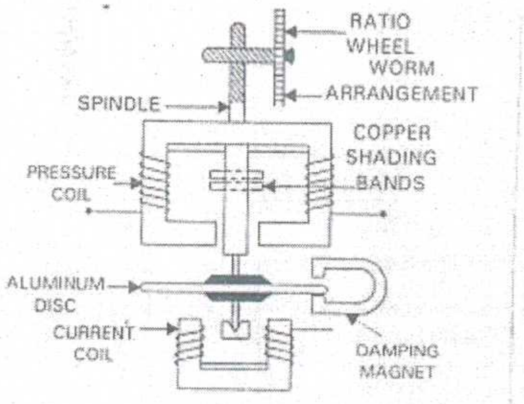
		3	6	6
II.5	The value of the earth resistance for different power stations is shown below Large Power Station – 0.5 ohms Major Power Station – 1.0 ohms Small Substation – 2.0 ohms In all other cases – 8.0 ohms	6	6	6
II.6	 Digital frequency meter The signal whose frequency we have to be measured is first to be amplified through amplifier. The output of amplifier is applied to the Schmitt trigger. The Schmitt trigger is convert input signal into a square wave which has a fast rise and fall time. The square wave is then	3		

	differentiated and clipped. Each pulse is proportional to each cycle of unknown signal. Now the output from Schmitt trigger is applied to a start and stop gate. The input pulses are allowed to pass through it, when the gate is open. The counter starts to count these pulses. The gate is closed the output pulses are not allowed to pass through the gate. The counter stops the counting. When the gate is open the number of pulse are counted by the counter. The interval between start and stop condition is the frequency of unknown signal which has to be measured. **F = N/t** Where, **F** = Unknown frequency. **N** = Number of counts. **t** = Time interval between start and stop condition of the gate.	3	6	6
II.7	Frequencydetermination Phase determination Measurement of AC/DC voltages Radiation patterns of antenna Engine pressure analysis Study of stress, strain, torque, acceleration etc. BH curves for hysteresis loop Amplifier gain, modulation percentage etc. (any six)	6	6	6
III. (a)	 Attraction Type Moving Coil Instrument	5		

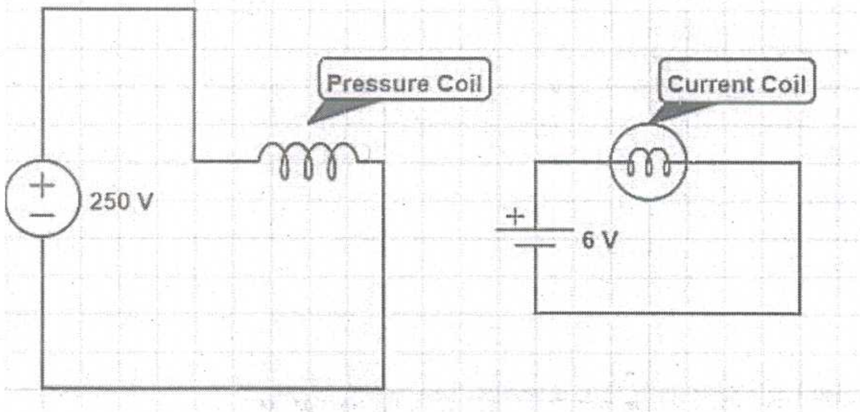
	The stationary coil of the attraction type instrument is flat and has a narrow opening. The moving element is the flat disc of the iron core. The current flow through the stationary coil produced the magnetic field which attracts the iron coil. The iron vane deflects from the low magnetic field to the high magnetic field, and the strength of the deflection is directly proportional to the magnitude of the current flow through it. In short, we can say that the iron coil attracts towards in.The attraction type instruments use spring, which provided the controlling torque. The deflection of the coil is reduced by the aluminium piston which is attached to the moving coil.	3	8	
III (b)	Gross Errors: includes all the human mistakes while reading, recording and the readings. Mistakes in calculating the errors also come under this category.Gross errors can be avoided by using two suitable measures and they are written below: 1. A proper care should be taken in reading, recording the data. Also calculation of error should be done accurately. 2. By increasing the number of experimenters we can reduce the gross errors.	2		
	Instrumental Errors:These errors may be due to wrong construction, calibration of the measuring instruments. These types of error may arise due to friction or may be due to hysteresis. In order to minimize the gross **errors in measurement** various correction factors must be applied and in extreme condition instrument must be re-calibrated carefully.	2		
	Environmental Errors:This type of error arises due to conditions external to the instrument. External condition includes temperature, pressure, humidity or it may include external magnetic field. Following are the steps that one must follow in order to minimize the environmental errors: • Try to maintain the temperature and humidity of the laboratory constant by making some arrangements.			

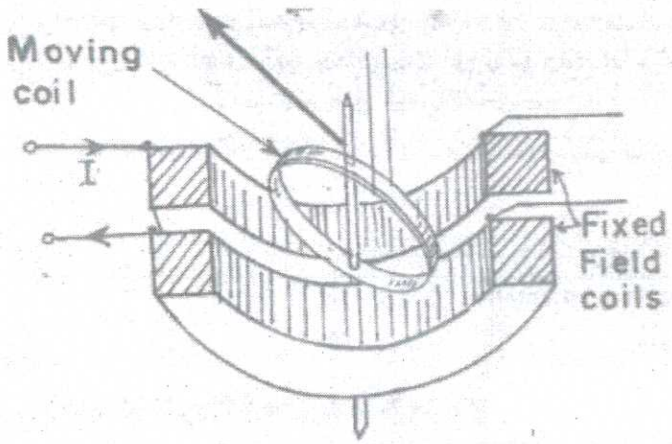
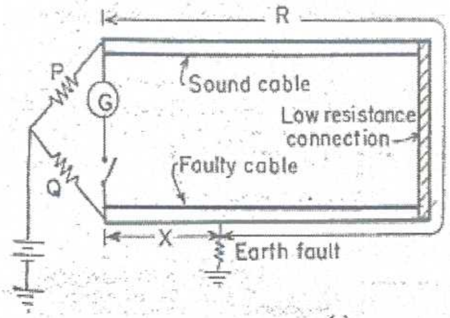
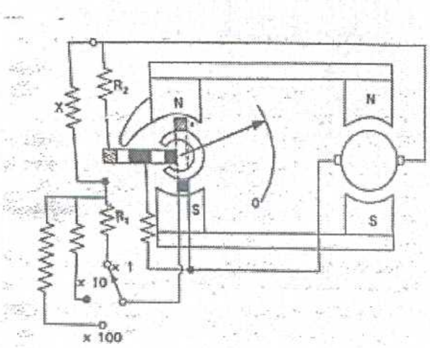
	• Ensure that there should not be any external magnetic or electrostatic field around the instrument. Observational Errors:As the name suggests these **types of errors** are due to wrong observations. The wrong observations may be due to PARALLAX. In order to minimize the PARALLAX error highly accurate meters are required, provided with mirrored scales.	2 1	7	15
IV. (a)	 Main parts Permanent magnet Rectangular coil Control springs Pointer Pivots and scale Dust proof case with glass window Two permanent magnet and in between a coil is placed. Coil is attached with the spindle and pointer. The working principle is when a current carrying conductor is placed in a magnetic field it will acted upon by a force.	5 3	7 8	15
IV (b)	In order to ensure proper operation of indicating instruments, the following three torques are required:			

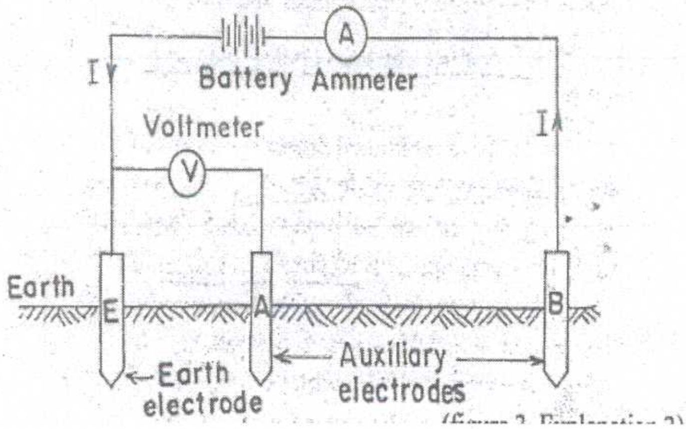
	• Deflecting torque. • Controlling torque. • Damping torque.	1		
	One important requirement in indicating instruments is the arrangement for producing operating or **deflecting torque** (T_d) when the instrument is connected in the circuit to measure the given electrical quantity.	2	7	15
	The controlling torque (T_c) opposes the deflecting torque and increases with the deflection of the moving system. The pointer comes to rest at a position where the two opposing torques are equal i.e. $T_d = T_c$.	2		
	A *damping torque* is produced by a damping or stopping force which acts on the moving system only when it is moving and always opposes its motion. Such a torque is necessary to bring the pointer to rest quickly.	2	7	15
V (a)		7		



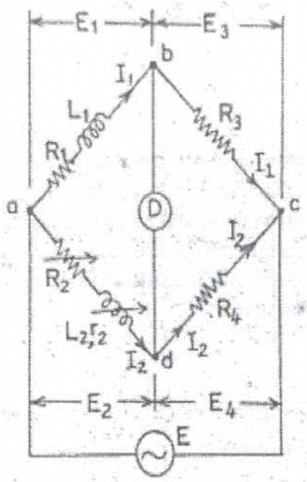
		5		
	An 'M' shaped pressure coil and a 'U' shaped current coil. In between these two, an Al disk is provided. When supply is given, pressure coil produce a flux ϕ_1 lagging with the applied voltage and proportional to the magnitude of the voltage. 'U' shaped lower magnet connected in series with the load and produces a flux ϕ_2 in phase with the load current. Due to the interaction of the two fluxes on the disk, an emf is induced on the disk and produces a circulating current. Due to the interaction of the three fluxes, torque is produced on the disk. (8)	3	8	

V (b)	Error due to Pressure coin inductance Pressure coil capacitance Mutual inductance effect Improper connections Eddy current Stray magnetic field Vibration of the moving system Temperature (any seven)	7	7	15
VI (a)	When a energy meter is designed for high current loads, it is uneconomical to arrange such loads for testing purposes as it involves a considerable waste of time and power. To avoid this problem "phantom" loading is done. In phantom loading, pressure coil is excited from normal supply voltage and current coil is excited from a separate low voltage supply. The low impedance of current coil circuit makes it possible to circulate the required current even with low supply voltage.	4		
		4	8	
VI (b)	Fixed coils (divided in to two halves, carry the load current, wound with heavy wire) Moving coil (Pivoted in a spindle, entirely embraced by the fixed coils, carry the voltage) Control (Spring control is used) Damping(Air friction damping) Scales and pointers(Mirror type scale and knife edge pointer) Shielding(To avoid the error due to stray magnetic field)	3		

	 	4	7	15
VII (a)	Murray loop test for ground fault At balanced condition P/Q = R/X X= Q/(P+Q) * 2r Distance of fault from testing end = Q/(P+Q) * 2l meters	4		
	 	4	8	
VII (b)	If the external resistance to be measured is infinity, deflecting torque is negligible and the controlling torque dominates bringing the needle to zero deflection position or Infinity position. On the other hand, if the external resistance to be measured is zero, the deflecting torque dominates the controlling torque and pushes the needle to the full scale deflecting showing the resistance is zero. For any other value of resistance the torque balances at a position showing its value of resistance.	3		
	 	4	7	15

<table>
<tr><td>VIII
(a)</td><td>A current is passed through earth electrode E to an auxiliary electrode B inserted in earth at a distance away from the earth electrode. A second auxiliary electrode A is inserted in earth between E and B. The potential difference V between E and A is measured for a given current. The resistance of earth is $R_E = V/I$</td><td>4</td><td></td><td></td></tr>
<tr><td></td><td>
</td><td>4</td><td>8</td><td></td></tr>
<tr><td>VIII
(b)</td><td>At balance $I_1Z_1=I_2Z_2$ and $I_1Z_3=I_2Z_4$
Hence $Z_1Z_4=Z_2Z_3$

$R_4(R_1+j\omega L_1)= R_3(R_2+r+j\omega L_2)$

Hence $L_1= R_3/R_4 * L_2$</td><td>4</td><td></td><td></td></tr>
<tr><td></td><td></td><td>3</td><td>7</td><td>15</td></tr>
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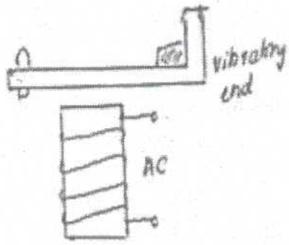
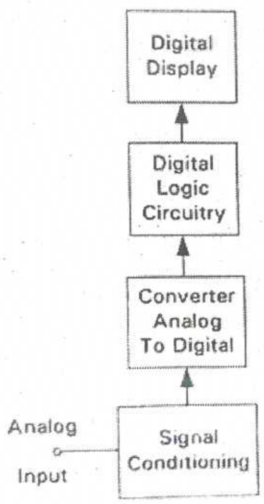
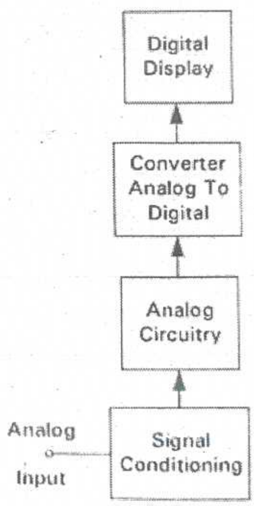
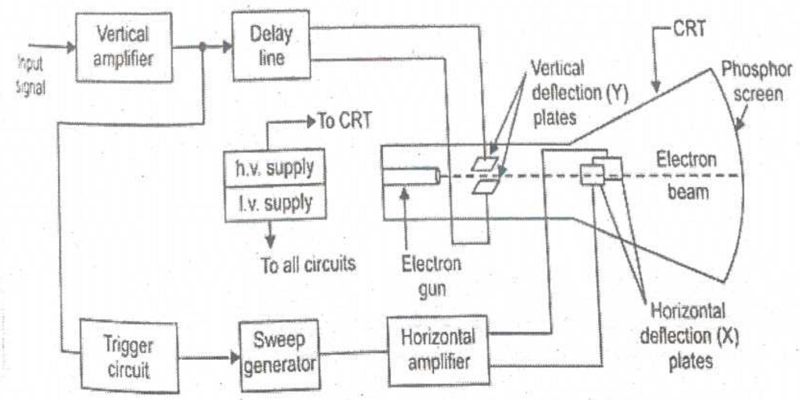
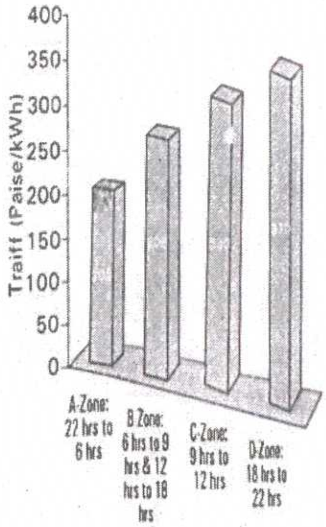
IX (a)	(a) 	3		
	It consists of a number of thin steel strips called reeds. These reeds are placed in a row and close to an electro magnet. The natural frequency of vibration depends upon their weight. The reeds are fixed at its bottom end. When supply is given the force exerted on the reeds varies every half cycle. All the reeds will tend to vibrate but the reeds whose natural frequency is equal to twice the frequency of supply will be resonance and will vibrate most.	5	8	
IX (b)	There are two class of digital instruments • **Digital instrument** - circuitry and indicator (display) are of digital nature. Digital instrument give clear readings in digits which can be read without any ambiguity thus the reading time is decreased. Besides this the digital instruments are more accurate, the readings hold good for a given temperature and frequency range. • **Digital readout instrument** - circuitry is analogue but the indicator (display) is of digital design. Digital read out instruments are cheaper and offers good resolution. They are versatile and adaptable. They are generally termed as digital multimeters.	4		
	(a) Block diagram of Digital Instrument (b) Block diagram of Digital Readout Instrument	3	7	15

X (a)	**BLOCK DIAGRAM OF CRO** 	4		
	1. Cathode ray tube: It generates the electron beam, accelerates the beam to a high velocity, deflects the beam to create the image, and contains a phosphor screen where the electron beam eventually becomes visible. It displays the quantity being measured. **2. Vertical amplifier.** It amplifies the signal waveform to be viewed. **3. Horizontal amplifier.** It is fed with a sawtooth voltage which is then applied to horizontal deflection plates. **4. Sweep or time base generator.** It produces sawtooth voltage waveform used for horizontal deflection of the electron beam. **5. Trigger circuit.** It produces trigger pulses to start horizontal sweep. **6. High and low-voltage supply:** HV Supply - provides the high voltages (on the order of a few thousand volts) required by the cathode ray tube (CRT) to generate and accelerate the electron beam. LV Supply - for the other circuits in the CRO **7. Delay line.** High frequency oscilloscopes always include delay line in the vertical amplifiers. The purpose of such lines is to delay the vertical signal enough to keep it from reaching the CRT deflection plates before the horizontal sweep circuits are running.	4	8	
X (b)	**Time of Day meter** (TOD) is designed based on the TOD tariff which involves dividing the day, month and year into tariff slots and with higher rates at peak load periods and low tariff rates at off-peak load periods. While this can be used to automatically control usage on the part of the customer (resulting in automatic load control), it is often simply the customers responsibility to control his own usage, or pay accordingly (voluntary load control). This also allows the utilities to plan their transmission infrastructure appropriately.	5		

	TOD Timings: Open with Figure shows TOD charges for different time zones for one of the Indian utility.  Different rates are applicable for use at different time of the day and night which encourage the consumer to switch to the time when prices are less or will use it efficiently which will result in supply power demand without drastically increasing the production.	2	7	15