CMR INSTITUTE OF TECHNOLOGY			USN								
Internal Assessment Test –III											
Sub:	Introduction to Electrical Engineering							Code:	*BESCK204B*		
Date:	07/09/2023	Duration:	90 mins	Max Marks:	50	Sem:	2nd sem	Branch:	Chemistry cycle		

Answer any FIVE FULL Questions

		Marks	OBE CO	OBE RBT
1 a)	Derive the expression for emf induced in the primary and secondary side of a transformer Transformers-4-5.pdf	[5]	CO4	L1
1 b)	A three-phase 6-pole 50Hz induction motor has a slip of 1% at no load and 3% at full load. Determine: i) Synchronous speed, ii) No load speed iii) Full load speed, iv) frequency of rotor current at stand-still. v) Frequency of rotor current at full load.	[5]	CO4	L3

i) $N_s = \frac{120f}{P} \Rightarrow \frac{120 \times 50}{6} = 1000$ rpm.

ii) No load speed $N_r = (1-s) N_s$

s at no load = 0.01

$\therefore N_r = (1-0.01)\,1000 \Rightarrow 990$ rpm.

iii) full-load speed,

s at full-load = 0.03

$N_r = (1-0.03) \times 1000 \Rightarrow 970$ rpm.

iv) at standstill $s=1$,

therefore $f' = sf = f$

$= 50\,Hz$.

at full load, $s = 0.03$

$f' = sf$

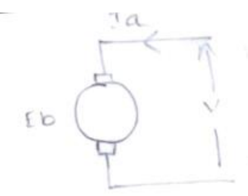
$= (0.03)\,50 \Rightarrow 1.5\,Hz$.

2 a)	Derive the torque equation for DC motor with suitable notations.	[5]	CO3	L2

Torque Equation :-

Voltage eqn of dc motor

$$V = E_b + I_a R_a \quad - (1)$$



$V = E_b + I_a R_a$

× Ia,

$$V I_a = E_b I_a + I_a^2 R_a \quad - (2)$$

$V I_a$ → elec i/p to arm

$E_b I_a$ → elec equivalent of gross mech power

$I_a^2 R_a$ → cu loss in arm

i.e input = output + losses

$E_b I_a$ - electrical equivalent of gross mech power - (3)

	et T be the average electro-magnetic torque developed by armature in Nm (newton metres) Mechanical power developed by armature $P_m = \omega \times T$ — (4) where $\omega = \frac{2\pi N}{60}$ i.e $P_m = \frac{2\pi N}{60} \times T$ Using (3) and (4), $E_b I_a = \omega T$ $\boxed{T = \frac{E_b I_a}{\omega}}$ — (5) w.k.t $E_b = \frac{P\phi N Z}{60 A}$			

	w.K.T $E_b = \frac{P\phi N Z}{60 A}$ Sub E_b in (5), $T = \frac{P\phi Z N}{60 A} \times \frac{I_a}{2\pi N} \times 60$ $T = \frac{1}{2\pi}\frac{P\phi Z}{A} I_a$ — (6) eqn (5) represents the torque eqn of dc motor Considering eqn (6), P, Z and A are constant for given dc machine, ∴ $T = K_t \phi I_a$ where $K_t = \frac{PZ}{2\pi A}$			
2 b)	A 6 pole lap connected DC series motor, with 864 conductors, takes a current of 110 A at 480 V. The armature resistance and the series field resistance are 0.18 ohm and 0.02 ohm respectively. The flux per pole is 50 mwb. Calculate (i) the speed (ii) the torque i) $N_s = \frac{120 f}{P} \Rightarrow \frac{120 \times 50}{6} = 1000$ rpm. ii) No load speed $N_r = (1-s) N_s$ s at no load = 0.01 ∴ $N_r = (1-0.01)\, 1000 \Rightarrow 990$ rpm. iii) full-load speed, s at full-load = 0.03 $N_r = (1-0.03) \times 1000 \rightarrow 970$ rpm. iv) at standstill s=1, therefore $f' = sf = f$ $= 50 Hz$. at full load, s = 0.03 $f' = sf$ [illegible] 50 $\Rightarrow$ 1.5Hz.	[5]	CO3	L3

3	With diagrams explain the concept of rotating magnetic field in an induction motor. Also, prove that the magnitude of resultant flux is a constant PDF three phase induction motor notes (1)-4-7.p	[10]	CO4	L2
4a)	Define "unit" used for consumption of electrical energy and explain the two part tariff with its advantages and disadvantages. the rate atwhich electrical energy is sold to the consumers istermed as 'tariff.' When the rate of electrical energy is charged on the basis ofmaximum demand of the consumer and the units consumed it is called two-parttariff. In this tariff scheme, the total costs charged to the consumers consist of two components: fixed charges and running charges. It can be expressed as: Total Cost = [A (kW) + B (kWh)] Rs. Where, A = charge per kW of max demand (i.e. A is a constant which whenmultiplied with max demand (kW) gives the total fixed costs.) B = charge per kWh of energy consumed (i.e. B is a constant which whenmultiplied with units consumed (kWh), gives total running charges.) • The fixed charges will depend upon maximum demand of the consumer and therunning charge will depend upon the energy (units) consumed. The fixed chargesare due to the interest and depreciation on the capital cost of building andequipment, taxes and a part of operating cost which is independent of energygenerated. On the other hand, the running charges are due to the operating costwhich varies with variation in generated (or supplied) energy. Advantages:• It is easily understood by the consumer.• It recovers fixed charges which depend upon the maximumdemand of the consumer independent of the units consumed. Disadvantages:• Consumer has to pay the fixed charges irrespective of the factwhether he has consumed or not the electrical energy.• There is always error in assessing the maximum demand of theconsumer.	[5]	CO5	L2
4b)	List out the power rating of household appliances including air conditioners, PCs, laptops, printers, etc. Calculate (a) the total power consumed. (b) Monthly Electricity bill	[5]	CO5	L3

House hold appliances

	Power consumer	for 1 month
i) Air Conditioner -	1.3 KW	= 1.3 * 10 * 30 (days) = 390 KWh
ii) TV -	90W = 0.09 KW	= 0.09 * 12 * 30 = 32.4 KWh
iii) Ceiling fan (2) -	80W = 0.08 KW	= 0.08 * 10 * 30 * 2 = 48 KWh
iv) Water pump -	1.5hp = 1.5 * 746 * 10^{-3} = 1.119 KW	= 1.11 * 1 * 30 = 33.57 KWh
v) led lamp (8) -	9W = 0.009 KW	= 0.009 * 24 * 30 * 8 = 51.84 KWh
vi) iron box -	1100W = 1.1 KW	= 1.1 * 1 * 30 = 33 KWh
vii) Printer -	375W = 0.375 KW	= 0.375 * 1 * 30 = 11.25 KWh
viii) Refrigerator -	380W = 0.38 KW	= 0.38 * 24 * 30 = 273.6 KWh

Considering this load conditions. electricity bill is Calculated as follows.

Considering 1unit = 3rs

Total KWh = 390 + 32.4 + 48 + 33.57 + 51.84 + 33 + 11.25 + 273.6

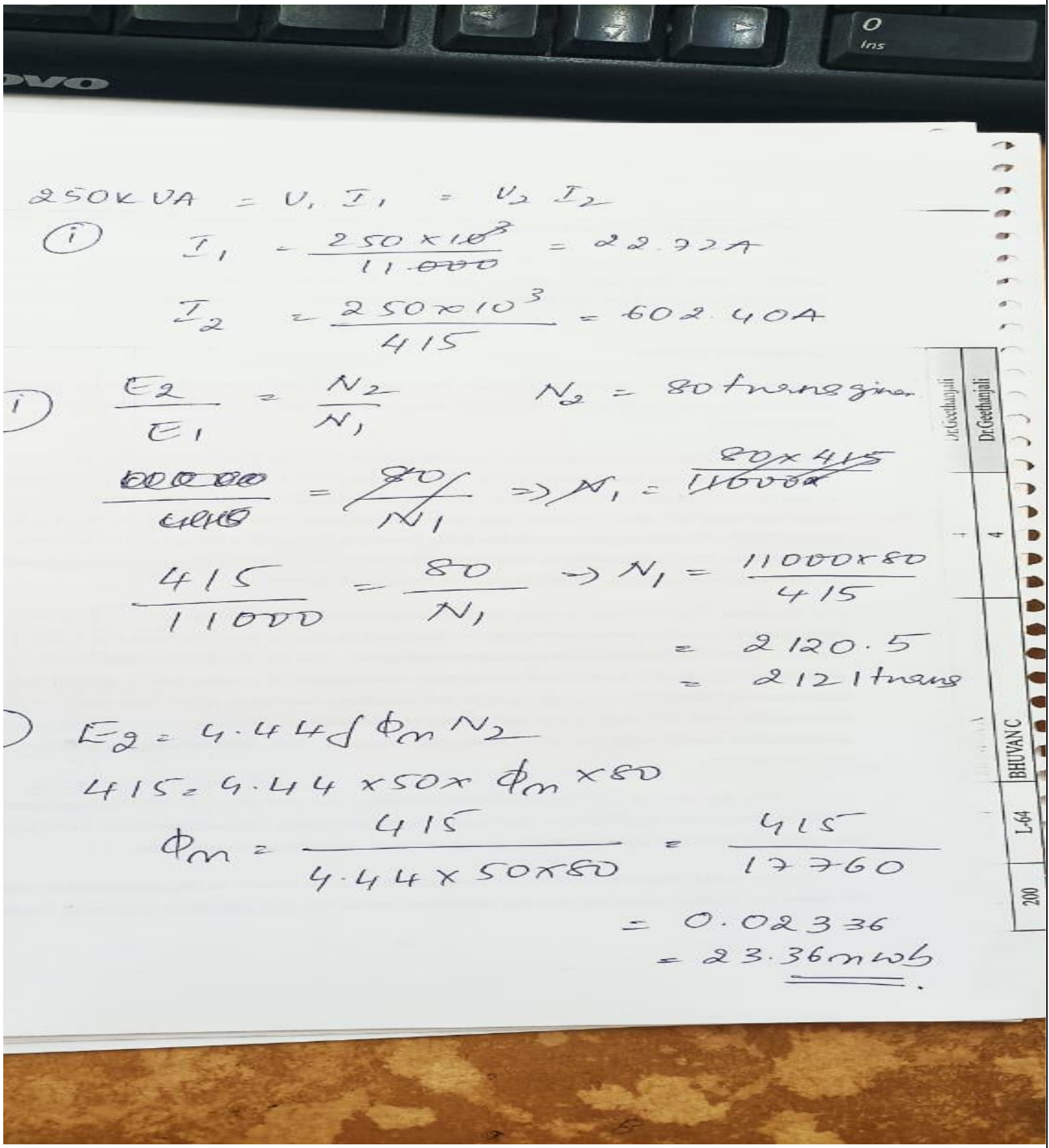
= 873.66 KWh

So, 873.66 units

So, Total tariff per month = 873.66 * 3

= Rs 2,620.98

5	A 250KVA, 11000/415 V , 50 Hz single phase transformer has 80 turns on the secondary , Calculate: (i) Rated primary and secondary currents (ii) Number of primary turns (iii) Maximum value of core flux (iv) Voltage induced per turn in primary and secondary (v) Turns Ratio	[10]	CO4	L3



$250\,kVA = V_1 I_1 = V_2 I_2$

(i) $I_1 = \frac{250 \times 10^3}{11000} = 22.72A$

$I_2 = \frac{250 \times 10^3}{415} = 602.40A$

(ii) $\frac{E_2}{E_1} = \frac{N_2}{N_1}$ $N_2 = 80$ turns given

$\frac{415}{11000} = \frac{80}{N_1} \rightarrow N_1 = \frac{11000 \times 80}{415}$

$= 2120.5$

$= 2121$ turns

(iii) $E_2 = 4.44 f \phi_m N_2$

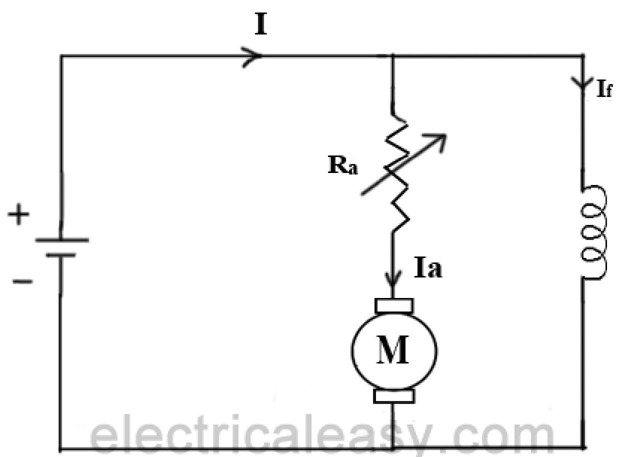
$415 = 4.44 \times 50 \times \phi_m \times 80$

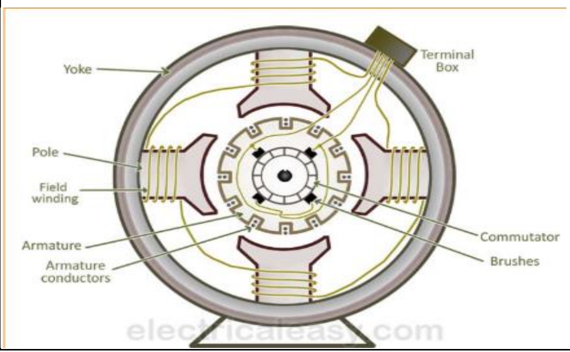
$\phi_m = \frac{415}{4.44 \times 50 \times 80} = \frac{415}{17760}$

$= 0.02336$

$= 23.36\,mWb$

6a)	A 6-pole generator has 400 armature conductors and has a useful flux per pole of 0.06wb. What will be the emf generated if it is lap connected and runs at 1000rpm? What must be the speed at which it is to be driven to produce the same emf if it is a wave wound? $\frac{11000}{N_1} = \frac{11000}{2121} = 5.186$ $\frac{415}{80} = 5.187$ turns ratio $= \frac{N_2}{N_1} = K = \frac{2121}{80} = 26.51$ $Z = 400 \quad \phi/p = 0.06\,wb$ lap connected 1000 rpm. $E_g = \frac{P\phi NZ}{60A} = \frac{0.06 \times 8 \times 1000 \times 400}{60 \times 8} = 400V$ $A = 2$ $E_g = \frac{P\phi NZ}{60A} = \frac{0.06 \times 8 \times 1000 \times 400}{60 \times 2} = 1600V$ Prof. Priyanka | 4 | PRAJAKTA MISHRA | 1CR21IS112 | 229	[5]	CO3	L3

6b)	Explain the various methods used to control the speed of D.C. shunt motor. 1. Flux Control Method-the **speed of a dc motor** is inversely proportional to the flux per pole. Thus by decreasing the flux, speed can be increased and vice versa. To control the flux, a rheostat is added in series with the field winding, as shown in the circuit diagram. Adding more resistance in series with the field winding will increase the speed as it decreases the flux. In shunt motors, as field current is relatively very small, I_{sh}^2R loss is small. Therefore, this method is quite efficient. Though speed can be increased above the rated value by reducing flux with this method, it puts a limit to maximum speed as weakening of field flux beyond a limit will adversely affect the commutation. **2. Armature Control Method**  **Speed of a dc motor** is directly proportional to the back emf E_b and $E_b = V - I_aR_a$. That means, when supply voltage V and the armature resistance R_a are kept constant, then the speed is directly proportional to armature current I_a. Thus, if we add resistance in series with the armature, I_a decreases and, hence, the speed also decreases. Greater the resistance in series with the armature, greater the decrease in speed. **3. Voltage Control Method** **a)** Multiple voltage control**:** **In this method, the shunt field is connected to a fixed exciting voltage and armature is supplied with different voltages. Voltage across armature is changed with the help of suitable switchgear. The speed is approximately proportional to the voltage across the armature.**	[5]	CO3	L2

7	With a neat diagram explain the Principle of operation and constructional details of a DC generator. Principle of Operation ➢electromagnetic induction ➢a changing magnetic field generates an electromotive force (EMF) in a conductor. ➢the basic components of a DC generator are a rotating armature, a stationary field magnet,and a commutator. ➢The magnitude of the output voltage is proportional to the speed of rotation and the strength ofthe magnetic field. Stator: This is the stationary part of the generator that houses the field magnet. The statorprovides the magnetic field required for the generation of the EMF. Yoke: Supporting frame and path for magnetic flux Poles: Salient poles – pole core – pole shoe – pole carries the field coils Field coils: Wound on pole shoes –supported by pole cores. All coils are identical and connected in series so that on excitation alternate N and S poles arecreated 	[10]	CO3	L2