MARINE ENGINEERING

By

Prof. Abdus Samad

IIT Madras

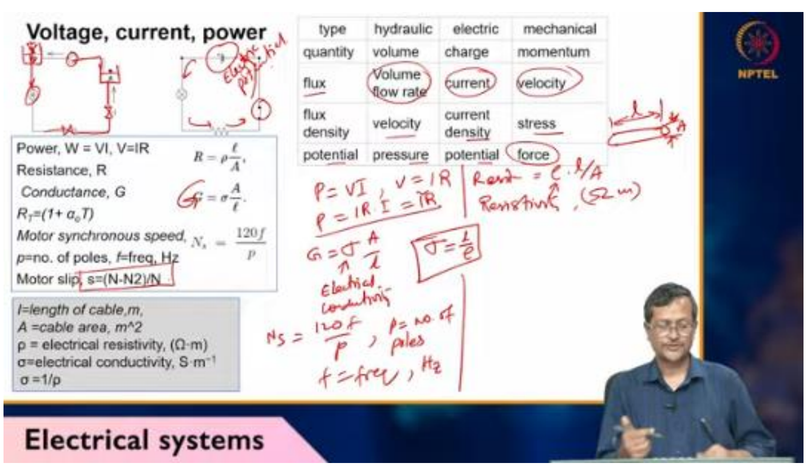
Lecture79

Electrical systems

good morning everybody this is the last portion of your course marine engineering so i'll give some basic idea about electrical systems used in your shipping or offshore applications electric systems you may have studied already in already in your first year classes but still some recapitulation is good uh for understanding of electrical system or whole marine engineering systems so for that you can take any basic electrical book electrical engineering book and or you can go through any website which is relevant to your basic things basic definition of power electricity current for example electricity voltage power current all these definitions you should know actually okay definitions along with unit for example i or current unit is ampere voltage is current voltage equal potential p is power power unit watt or kilowatt okay similarly you can see resistance ohm and other parameters also you should remember so voltage and current actually you can compare with hydraulic system or mechanical system you can see this one one circuit is here one fluid stored here okay atmospheric pressure is here and fluid is going through this there is one valve and it is going through this valve again control valve is here then again going back to here and one pump is working so this way fluid is circulating so similarly if you have one electrical source so electric source okay so in that case electricity will be flowing it will be getting resistance then there is switch okay again it will be going to back to your electric potential your electric source area so power equals v into i v equals i r so power will be i r into i so i square r

So, this is the formula you should remember resistance equals rho L by A, L means conductor length, conductor or wear length, small l is given there and area. cross section area of this conductor so and rho rho is your electrical resistivity rho is electric resistivity okay unit will be ohm meter now sigma conductance you see conduction g g is formulated as sigma A divided by L just opposite of rho resistance. So, sigma is equal to conductance electrical conductivity electrical conductivity A and L already I defined. So, sigma will be 1 by rho

okay uh in l is the length of the cable now you compare the quantities quantity flux negative flux is volume flow rate and electrical system we see current and mechanical system we say velocity flux density velocity current density stress potential pressure potential electric potential and force mechanical system so you should remember how it is matching so it will be easier to remember maybe if you remember electrical part you can remember mechanical part if you remember mechanical part electric part also can be easy to remember and motor synchronous speed ns equals 1 1 2 f by p p is number of poles magnetic poles are there f is your frequency hertz and motor slip motor slip is given here s equals n minus n 2 divided by n so this is called motor sleep so initial theoretical calculated motor n but when you run motor motor speed little bit reduced so n minus ratio speed divided by original speed so original speed minus reduced speed divided by original speed so that ratio is called motor slip so this is expressed in terms of percentage so normally copper wire copper is having higher conductivity may be electrical or heat both cases copper carries higher amount of heat or electricity higher heat or electricity it may not be the highest one but because of cost and other aspect and your usability based on that copper people will be using for electrical conductive purposes the single solid configuration or multiple small strand configuration multiple small smaller you take and you wrap it so that way also it will be used the stranded cable is mechanically flexible standard cable means you can see this right side picture so multiple cables are here one two three four multiple girls and like it will be given little bit winding so that way it will work

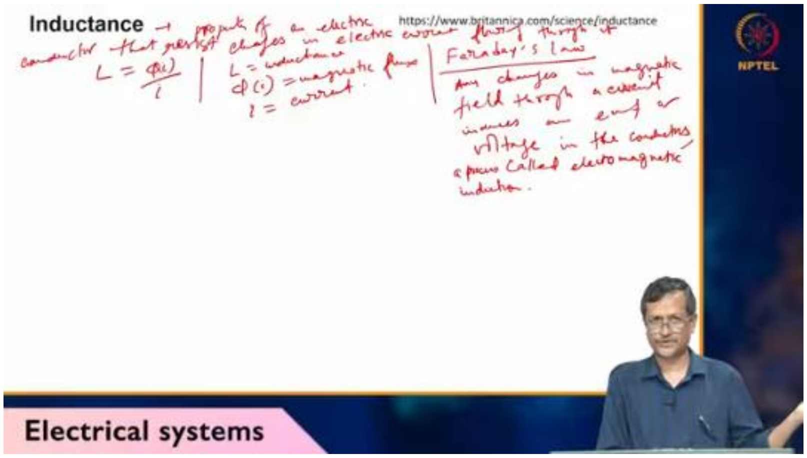


braided wear multiple strand or flexible wear wound for higher amount of current if you are carrying and insulation is also very important for marine application in that case actually multiple level of insulation will be provided but in normal application for your let us say household application for electricity bulb fixing so in that case you do not need so strong cable plus insulation level but for especially marine and difficult areas where insulation may cause a severe issue there you use a heavy insulation and carry current rated motor torque hp goes 5 to 5 0 divided by n n is motor rated speed hp horsepower equals t omega i am telling this formula again and again conduction low resistance to electron insulation electric current does not flow freely atoms tightly bound in electrons so whenever there is a conductor so there will be one insulator just to protect the conductor okay and especially in shipping applications any open wear must not be kept anywhere So, semiconductor, electrical resistance between metal and insulator, so semiconductor. And different material will have different resistivity.

So, a silver is having resistivity 1.59, you can see this is a very low resistivity, relative to copper also, but silver is not used because it is extensive. so similarly aluminum also has similar resistivity as copper so many other material also will have more or less resistivity especially copper silver gold maybe those are having lower resistivity but you cannot use every time because some will have higher cost some will have some other issues so normally copper will be common some in many cases aluminum also used for your electric electrical conductor So, inductance, so you have learned all these terms and inductance and some other terms also there you have to remember. So, property of induct electrical conductor, this is a property of an electric conductor that resist changes in electrical electric current flowing through it so inductance l equals phi i divided by i so l is inductance

phi i magnetic flux and i is your current okay so faraday loses faraday's law so further any changes in magnetic field any changes magnetic field through a circuit circuit induces an emf electromotive force or voltage in the conductors. A process is a process called electromagnetic induction. okay so this magnetic induction is in many places for example induction motor for example for example your induction heater is there at home and induction charger these days electric vehicle charging or many uh that wristwatches watches are there you don't have to put your cable now that you put on induction surface so there it will be automatically charging through induction or

Many places the scientists are thinking whether road can be placed such inductor so that whenever car is moving it will be charging automatically during moving also. So, there will be no cable connection other through induction the recharging will be happening. So, here one picture I will show not picture it is video. So, you can see actually how electricity and magnetism are linked. so it is for our wave energy system wave energy system we have wave okay and we have one floating device floating device is having one hole inside okay and one rod is coming here flat rod it is almost fixed to the bottom when wave is moving up and down my boy is moving up and down this is boy this part this is part this is boy

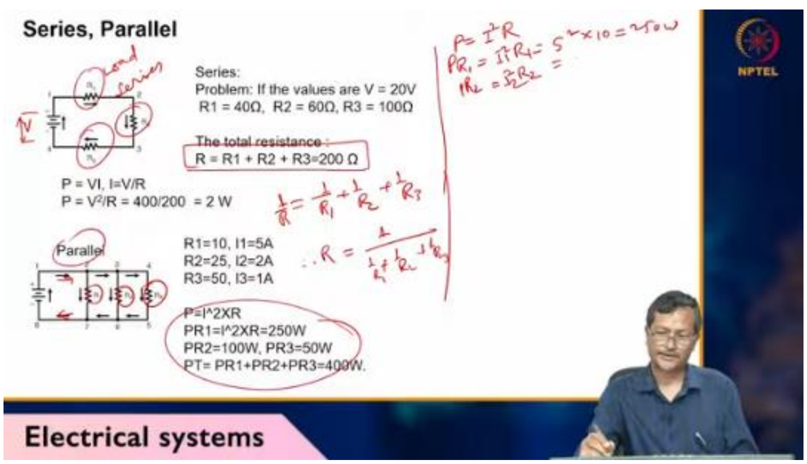


So, when boy is moving up and down my spar is not moving. So, because of that I am getting relative motion between boy and spar. So, boy and spar is creating relative motion okay when relative motion is created you can see this rod is coming out from here it attached lots of magnets okay and i have coil here all around okay these are magnets and this is coil what is happening when my system is working you see the video again here when wave is moving up and down your my buoy is moving up and down my spar is not moving so I'm getting one relative motion buoy is moving spar not moving so I'm getting relative motion between this now my spar having certain some magnets okay

so the magnets are fixed on spar and coil all around that is connected to my boy so boy is having connected to coils so boy is designed such way it will be fixing fixed with coils okay electric coils and it is having some central hole and this magnetic rod is coming and magnets are going going going through this so all these are having magnets the rod so whenever boy is moving my coil is moving up and down my magnet is fixed okay coil moving up and down magnet fix because of this one this uh coil is getting emf electromotive force so coil is getting emf so how to sense you see the video again you see this right side this one this data digits will be changed when my system is moving you see this i am producing electricity here i can see okay so you can see this three five volts uh not volt i think some ampere current it is showing ah so when there is relative motion between magnet and coil we are producing electricity so similar way all other electrical system motor generator and linear motor linear generator those will be designed actually those are getting designed and this is specific practical application for wave energy converter in europe and sweden many people has implemented implemented practically in our laboratory we have done its laboratory system we are trying to uh scale up now whenever talking about electricity so you should know the parallel connection and series connection here first picture is series this is parallel connection okay so in series connection all the loads are resistances resistance being load

Resistance 1, resistance 2, resistance 3, resistance 4, those will be added actually. Because see the formula R equals R1 plus R2 plus R3 plus whatever loads are there. This is EMF you are applying voltage. But in parallel connection, the resistances will be inversely connected. For example, R1, R2, R3, three resistances are there and electricity is flowing.

So, in that case I have R1 plus 1 by R2 plus 1 by R3 equals 1 by R. Therefore, R equals inverse proportion inverse of 1 by R1 plus 1 by R2 plus 1 by R3. In parallel circuit it is power is calculated or is calculated like this we know power equals i square r okay so for r1 power is becoming like i square r equals for r1 power is current is 5 so 5 square into r r value is given 10 so 250 watt so p r 2 I square R2, I2 square R2. So, I can say like this, I2 means 2 square into 25, so 400, P R3 we get 50.

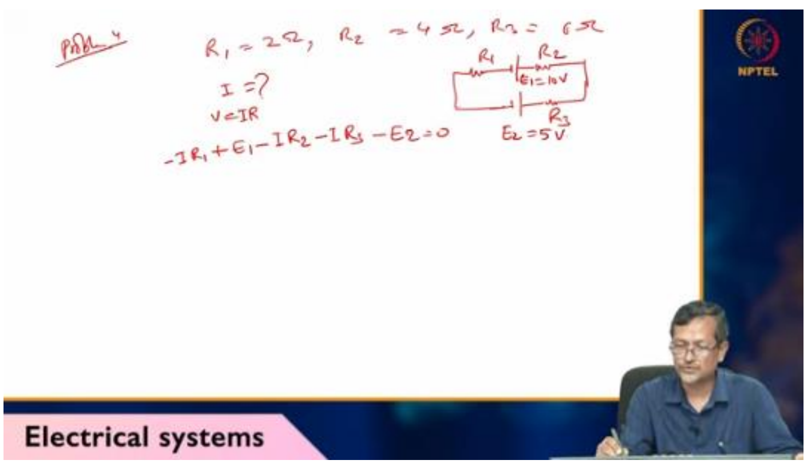


So, total power we are getting PR1 plus PR2 plus PR3 equals 400 watt, Kirchhoff's law. So, Kirchhoff has two law, one is voltage law and its current law. So, Gustav Kirchhoff produced these two laws. to for conservation of voltage and current.

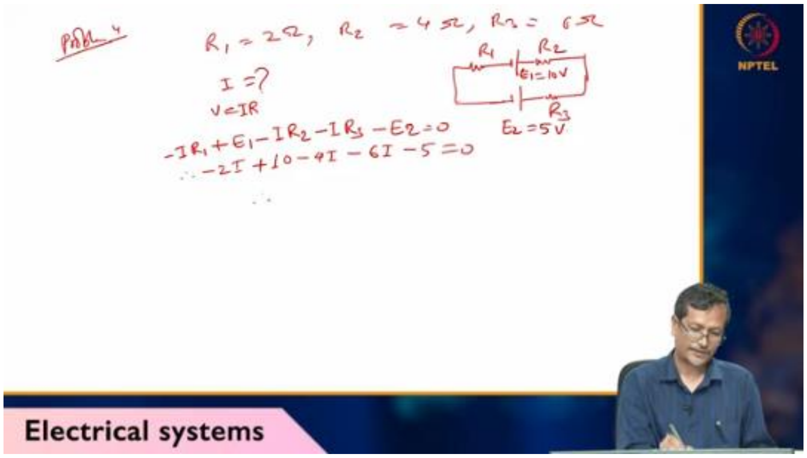
So, voltage and current like let us say I have one node and one current is coming like I1, another current coming I2, another coming I3 and outgoing I4, I5. So, this is current out, this is called node. node this is current in. Now, as per the current law I1 plus I2 all current entering into the node and exiting node total will be 0. So, I3 minus I4 minus I5 equals 0. So, this is your current law. So, one node can have multiple input, multiple output, but total current will be 0. So, this is the conservation of current law of current. and this is current law or first law second law second law it is voltage law or energy law energy conservation law so here we say resistance R1 R R

R. So, I have resistances like this, A, B, C, D. So, V voltage AB, A to B across R plus voltage BC plus voltage CD plus voltage DA equals 0. So, total voltage around a loop, so total voltage around a loop equals the sum of every voltage drop in the same loop for any closed network. and equals to 0. This is called conservation of energy law.

Let us say one problem, problem 4 I think. So, let us R1 equals 2 ohm, R2 equals 4 ohm, R3 equals 6 ohm and circuit is like this. resistance here then she's coming another resistance here then again okay r1 r2 r3 e1 equals 10 volt e2 equals 5 volt i current you have to calculate so let's catch of direction law v equals i r v equals i r so minus i r 1 plus e 1 minus i r 2 minus i r 3 minus e 2 equals 0. so here high to low when source voltage is there so you take positive and current when is going from high to low you take negative so the values are like this 2 i my plus 10 10 minus 4 i minus 6 i minus 5 equals 0.



therefore i equals 0.416 ampere okay this is your solution thank you very much for today's lecture tomorrow we'll continue this one and we'll finish our marine engineering course thank you very much



114106534_Lecture79_English

by

Prof. Abdus Samad