**MARINE ENGINEERING**

**By**

**Prof. Abdus Samad**

**IIT Madras**

**Lecture 80**

**Motor**

Good morning everybody, we are on the last week of our Managed Engineering course. So I already started electrical system, the motor electrical part like basic electrical So, let us see some of the topics which may not be very in-depth study, rather some basic idea about electrical engineering. So, normally in engineering system, there will be AC three-phase system, AC three-phase system. So, 440 volt or 6600 volt, okay.

And there will be emergency power supply, emergency power supply like steering gear, So, emergency bilge area, fire pump, water tight doors, firefighting areas, navigational system, communication system and alarm system they must have emergency power system. So, emergency power when you are talking about then you must have one battery system. Okay, so battery will be storing energy. So you produce power from IC engine or any other gas turbine engine.

Then that engine will be giving power to the generator. Generator is electric generator to be producing electricity. That electricity will be stored in battery. Some will be directly going to your main marine machinery, maybe ported propeller or thruster. And some energy will be stored in battery.

So battery will be giving power during demand whenever you need or your main machinery is not working or you need extra power in certain specific time. So that time the battery will be supplying your power. Many time your solar power boat and other newer boats with renewable energy system. So they need some storage of battery because peak demand they need to fulfill from battery. so engine may be running continuously but some peak demand will be coming so that time you can supply from battery and other time you store the power in battery so uh normally the the cable will be having with higher voltage so higher voltage required because i square r so the if if you increasing high voltage power

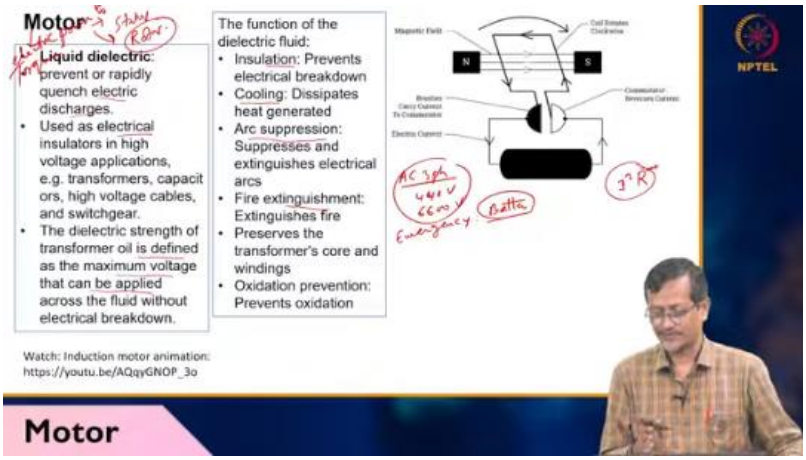
then i square r will be lower and all the cable must be properly insulated uh no uh cable can be opened

is to also there will be several instrumentation ammeter voltmeter thermocouple rectifier so several those instrumentation will be required to check your voltage and current parameter power parameter okay So, now we will discuss about motor. So, motor actually you have seen from your undergrad class like first year class or maybe plus two class. Motor will have some dielectric fluid. Sometimes we say transfer of fluid.

So, motor stator will be there. So, motor will have stator and rotor. So, rotor will be rotating inside stator. So, when rotor and stator, stator is rotating, rotor is rotating inside stator there will be some fluid that is called dielectric fluid. So, that will be preventing rapidly electric discharge or otherwise it will start fire.

So, electric insulation must be high for high voltage application and transformer, capacitor, high voltage cables and switch gears they must have that dielectric fluid inside there. The dielectric strength of transformer oil is defined as the maximum voltage that can be applied across the fluid without electric breakdown. So it should not create any spark and it should give cooling effect, it should give lubricating effect. The function of dielectric fluid like this, it will be acting as insulation, it will be acting as a coolant, it will be suppressing arc, if there is any arc creation is there, so arc will have very high amount of energy, so that amount of energy should not harm your electric circuitry. Then fire extinguishment it will do an oxidation prevention.

So it should not allow any oxidation of your any other material inside motor or generator. So for regarding motor and generator please go through basic electrical engineering books or maybe lots of YouTube videos are there how the motor and generator works you should know. So motor means it will be taking electric power and it will be giving rotary torque. Okay so motor will give torque. and it will be taking electric power power to torque it will be producing so electrical energy will be converted to mechanical energy so there will be certain amount of losses but losses will be very much minimal if you design properly now we have generator generator function is just opposite of motor of motor



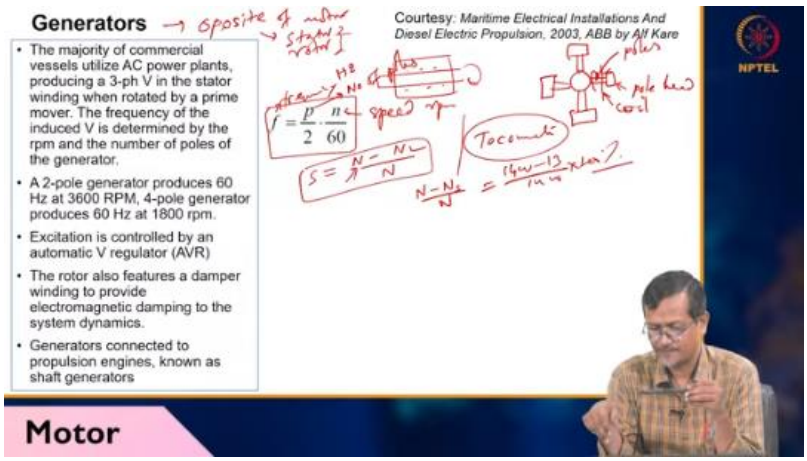

So, electric generator it will have stator, rotor, main component then rotor will be rotating it must be hold by bearings ok. Already we discussed about bearing. So, bearing will be holding on the radial loads. So, some small amount of thrust load also be holding, but not much. So, you should not give any lots of thrust load on this bearing.

So, it will be basically designed for torque transmission and taking some radial load ok. It will have rotor and stator. and again inside this let's see if i have one generator so rotor will be rotating inside it okay so it will be filled with your dielectric fluid or transform oil normally three phase supply will have and the formula frequency and this is number of poles and in is speed rpm number of so then if you know number of poles and rpm then you can calculate frequency or if you know electrical frequency number of poles then you can calculate number of rotation of the shaft or rotor. Rotor will be rotating the name says rotor means it will be rotating the stator will not rotate.

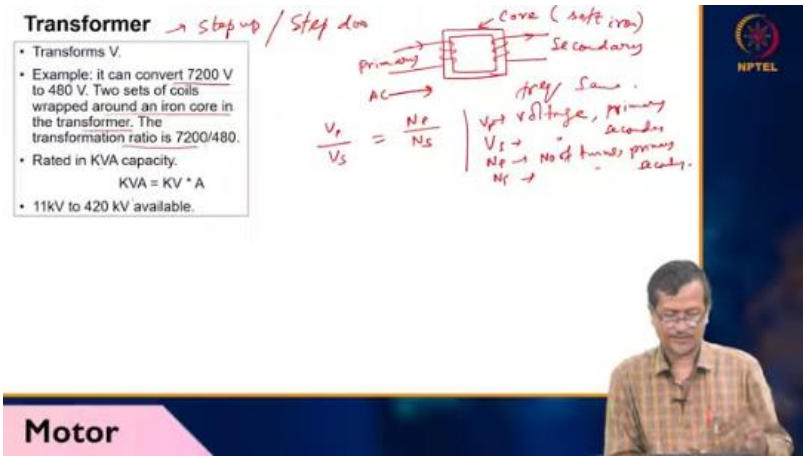
So, if I consider the rotor coil it will be like this it will have magnet and magnet end will be there okay so many poles will be there so these are poles okay and these are called pole head okay and coils will be wrapped around here okay so if you give electricity in the coil so your magnetic flux will be cut by the uh by this magnet so based on the electric frequency rotation will be started so please go through the details about how rotor and stator rotor will be rotating inside stator in motor or generator so please go through those youtube videos i have given some link also you can go through some other links also so motor slip or so motor or transformer generator slip will be like this slip n minus n2 divided by n n is rpm actually calculated rpm you get like say 1400 rpm but when you apply load in motor so actually your speed will be reduced a little bit when its speed is reduced so how much speed will be reduced so that you can calculate using slip so normally motor will have five percent ten percent slip so your motor calculated speed is let's say 1400 rpm but

actually when if you take one tachometer tachometer okay or speedometer so tachometer will be giving speed so normally tachometer what does it do you have rotational shaft okay and you put one reflector here and tachometer will be sensing how many times this reflector is giving reflected light back to the tachometer so it will be counting that one in that way tachometer will be giving rpm

so your calculated rpm let's say 1400 rpm but tachometer is giving 1300 rpm so your slip will be n minus n s by n that means 1400 minus 1300 divided by 1400 so that will be a slip so you express this one in terms of percentage actually into 100 you put okay so this is a percent slip and all motor if you have synchronous motor then your speed your calculated speed and rpm will be same but if it is not synchronous normally industrial motor will not will have the slip uh sleep will be three to five percent about okay and if you increase load the sleep will be much higher so uh transformer so transformer it will be transferring voltage so voltage if you want to go for step up or step down so step up or step down efficiency will be very high 98 99 and if you want to increase voltage say 440 volt is coming you want to reduce to 220 volts and you have to reduce transformer and transfer how to reduce it this formula or the basic principle is very easy so you have primary side coil okay this is called primary primary or supply side coil and you have delivery side or output side okay let's say this one output this is secondary side okay this is called core normally this core will be a soft iron okay because you have to magnetize this one and magnetic flux will be moving around so magnetic flux will be exciting the second coil and second will get electricity and frequency if you give AC current so frequency will be same actually in output side also okay and what is the how much voltage will be step up or step down so formula is that voltage primary side voltage secondary side speed np number of turns for primary side number of turns secondary side so V voltage



Vp primary side, Vs voltage secondary, Np number of turns in coil, the coil wrapped around the core. So, number of turns in primary, Ns number of turns secondary. okay so let's see it can convert 7200 volt to 480 volt two sets of coils wrapped around an iron core transformer the transformation ratio is called transform in transformation ratio like 7200 volt divided 480 so that ratio is called transformation ratio so rated kva uh kv normally transform will be rated in terms of kva kilo volt ampere okay so kv into ampere okay so 11 kv to 420 volt we can convert Now VFD variable frequency drive so in my laboratory also we purchase on a variable frequency drive I can I think I have explained this one during pump lecture so pump speed if you want to change because if we change speed or flow rate or head can change okay so instead of doing manually or mechanically we use VFD we change VFD will be changing frequency electrical frequency change that means motor speed will be changed. Okay.




So you can remember the formula F equals N P by 120. So N P 120 this formula is there. So if you change electrical frequency number of pole is same then your N will be changing. Okay. So in our case we change electrical frequency then we change motor speed.

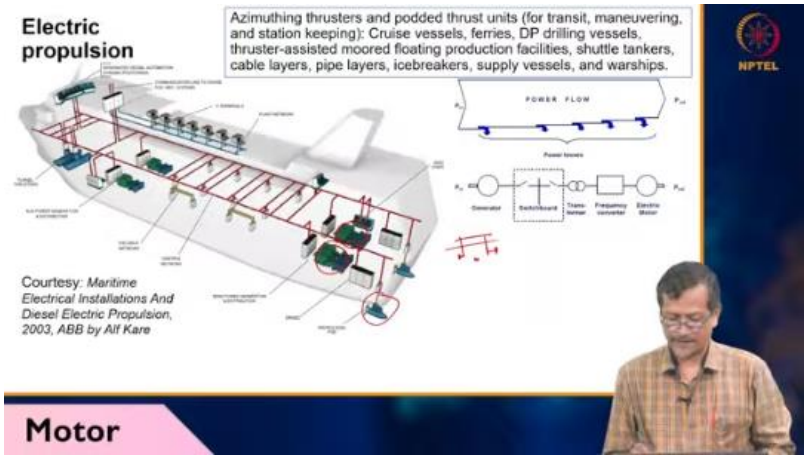
So motor speed change my flow rate and head. Okay, so there are different types of VFD or variable frequency drive or VSD or variable speed drive available. So based on your requirement, you can buy and you can use for your onboard application. For example, propeller speed you want to change. So just you can change electrical speed and podded propeller or thruster speed you can change.

So, there are lots of electrical propulsion systems also available for shapes, semi-submersible, offshore platforms. So, offshore platforms, for example, you have dynamic positioning system. I think you will be studying that one. Dynamic positioning means like

you have semi-submersible. And semi-submersible, if you are moving left side, right side, forward, backward.

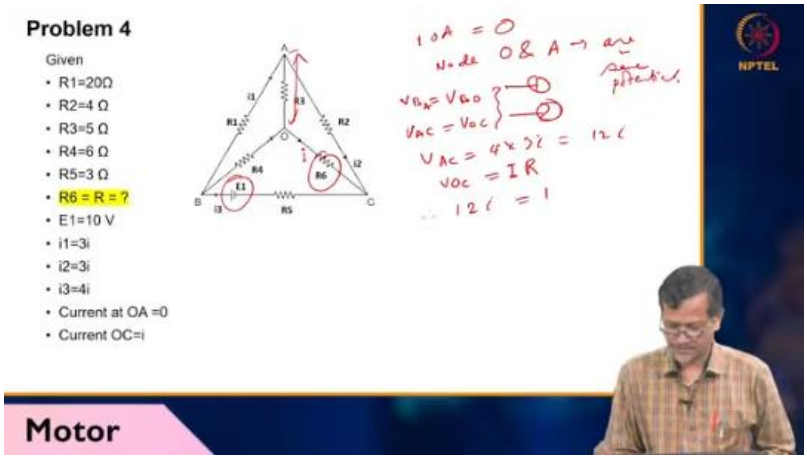
So, in that case, actually using some thruster, you relocate or reposition it. So, that is called dynamic positioning. So, like say I have one semi-submersible like this. and i will have one thruster here i will have one thruster here i will have thruster front side back side so let's say if it is moving this side i will have one thruster to be moving reposition it right place again because of wind motion or water motion it is moving this direction again one thrust will be working a reposition again and how this position will be detected based on his satellite data from satellite to be repositioned in proper location okay that way although you don't have any mooring may or may not be there but you can still reposition your ship or semi-submersible or offshore vehicle on a specific position using your satellite data along with your thruster propeller system okay so electrical propulsion system say you have one main engine so main engine will not drive directly your propeller rather engine will be producing certain power it will be giving to generator so generator will be producing electricity so the electricity can be stored in batteries

Okay or some power will go directly to your propeller system and remaining power can be stored in battery. So, in that way you reduce mechanical component space and mechanical component difficulties. So, you directly you run your propeller system using electrical system. Okay. So, we have seen Kirchhoff's law.

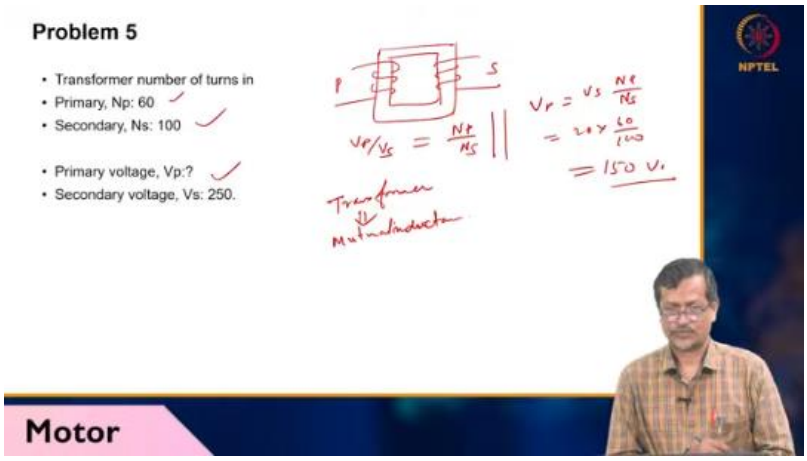



So, here we have one circuit where electromagnetic force is given here at U1, but you have to calculate R6. Okay. The current is given I1, I2, I3 and resistance R1, R2, R3 is given. So, you have to calculate R6. So, it will be done like this.

IOA is given 0. So, O2A, this one is given as 0 in the problem and that means node O and A are same potential. okay so v b a v b o also b v a c equals v o c okay you can see this from the picture this one this is two so v a c equals four into three i you can see current and ampere is given so it is given twelve i and v o c equals i r okay voltage because current and resistance therefore 12i equals ir r r equals 12 ohm so this is your calculation result this is coming from karshak's law so another simple problem on transformer is there np is given 60 n is given 100 primary voltage vp you have to calculate so first you draw your transformer okay so transformer if you draw a coil like this it will look better okay primary secondary now vp by vs equals np by ns the formula we know already so vp equals vs and p by ns so now put the values 20 into 60 divided by 100 is given 150 volt




okay so transformer actually based on is work based on mutual inductance mutual inductance okay it also transfer power by electromagnetic induction and electric power transfer without any frequency modification so frequency will be same in primary side and secondary side So, thank you very much for today's lecture, next lecture I will conclude the marine engineering



114106534_Lecture80_English

by

Prof. Abdus Samad