निर्माण प्रबंधन (Construction Management) के सिद्धांत

[Nirman prabandhan (Construction Management) ke Siddhant]

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Lecture – 17

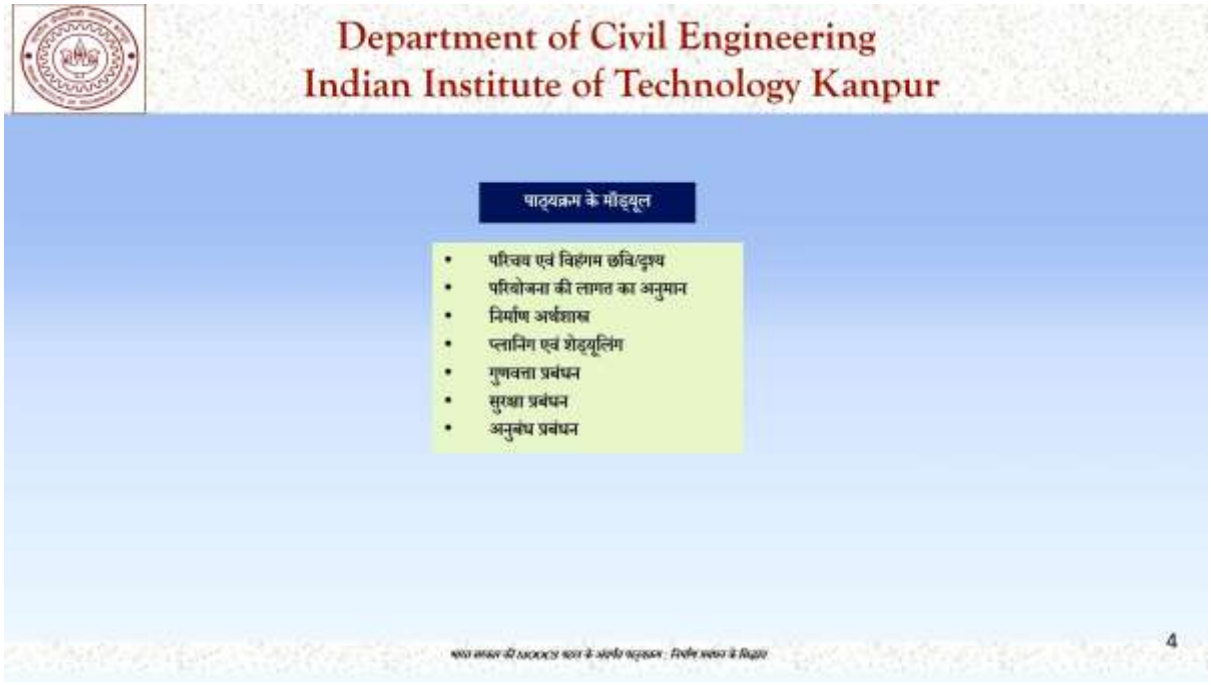
Network ka prayog evan critical path – I

Namaskaar aur svaagat hai aapaka ek bar phir Bhaarat sarakaar kee Moocs pahal ke antargat pathyakram Nirmaan Prabandhan ke Siddhaant.

(Reference Time 00:23)

Aaj ham lecture 17 karenge aur network ka prayog evan critical path is par charcha karenge.

(Reference Time 00:34)



Is pathyakram mein jin modules par charcha ho rahee hai vah yahaan dikhae gae hain. Parichay evan vihangam chhavi, pariyojana kee laagat ka anumaan, nirmaan arthashaastr, planning evan scheduling, gunavatta, suraksha evan anubandh prabandhan.

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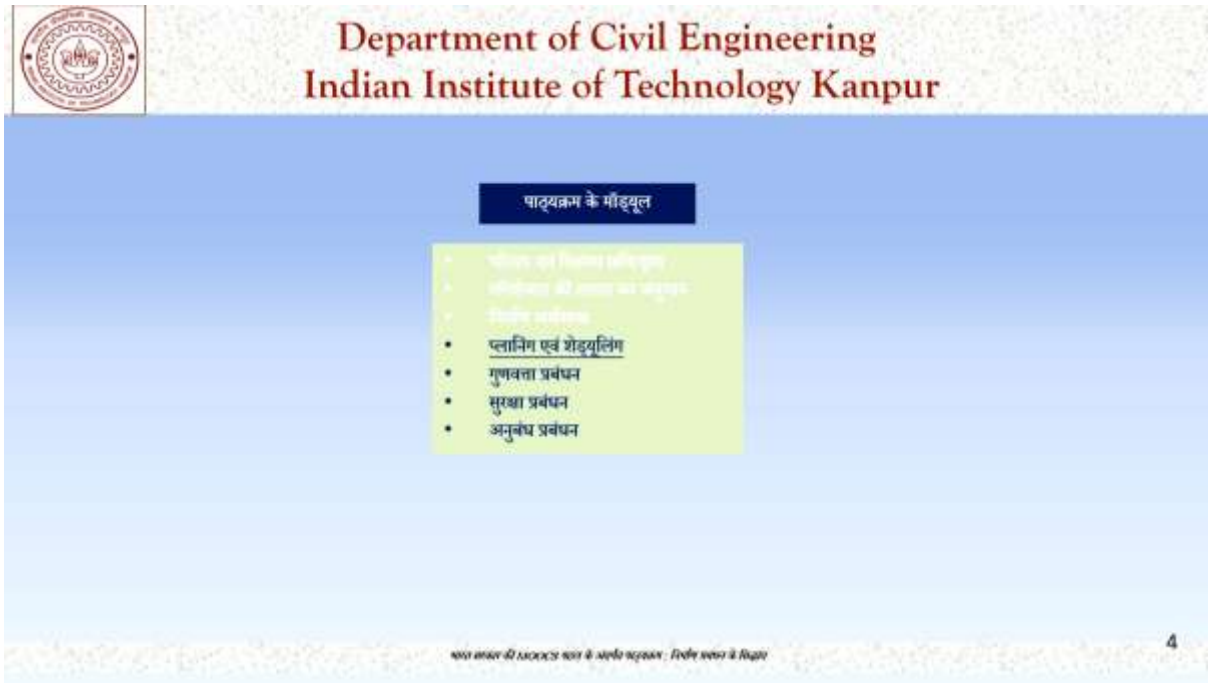
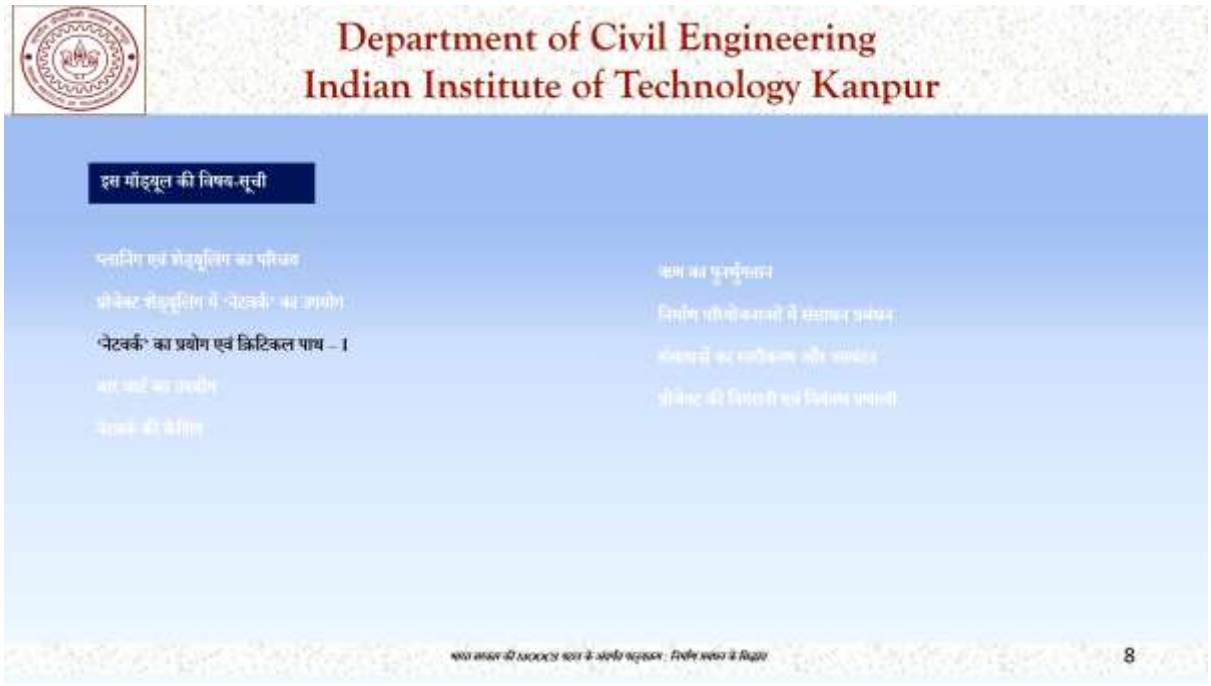


Inamen se hamaaree charcha abhee chal rahee hai planning evan scheduling par.

(Reference Time 00:52)

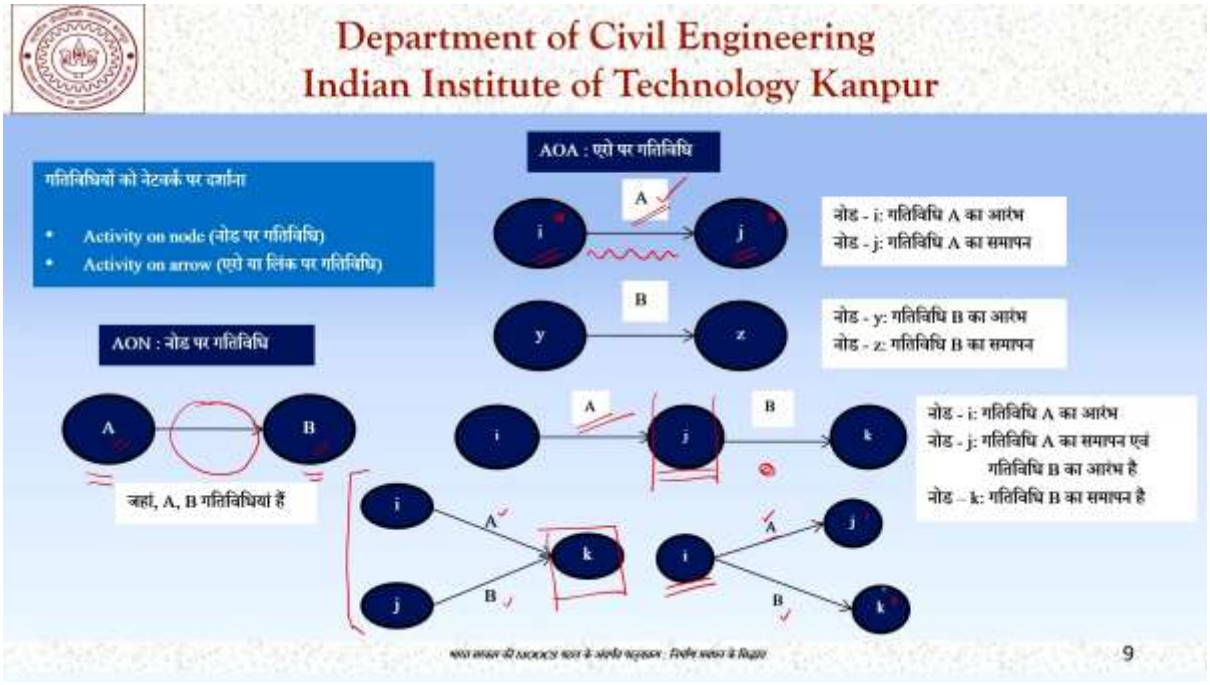
Aur is module ke antargat ham in vishayon par vichaar kar rahe hain planning evan scheduling ka parichay project scheduling ke lie network ka upayog critical path aur gatividhiyon kee avadhi mein anishchitata jisakee charcha ham PERT ke antargat karenge. Bar chart ka upayog, network kee crashing, rin ka punarbhugataan, nirmaan pariyojanaon mein sansaadhan prabandhan, sansaadhanon ka stareekaran aur aavantan aur project kee nigaraanee evan niyantran pranaalee.

(Reference Time 01:23)



To aaiye ham log network ka prayog evan critical path is par aaj praarambhik charcha karate hain jahaan par ki ham kuchh mahatvapoorn concepts par najar daalenge.

(Reference Time 01:33)



Hamane pahale bhee dekha tha ki gatividhiyon ko network par do tareekon se darshaaya jaata hai. Ek hai activity on nodee aur ek hai activity on arrow. To activity on nodee kee jab baat hotee hai vahaan par do gatividhiyaan A ya B nodee par dikhaee jaatee hai jaise ki yahaan dikhaee gaee hai. Yah ek nodee hai aur ek nodee yah hai isake beech mein yah arrow laga hua hai. To A aur B donon nodees par hain aur inako yah arrow connect kar raha hai jode raha hai. Isase ham kya abhipraay nikaalate hain? Ki A activity ho jaane ke baad B activity kee jaegee in other words (doosare shabdon mein) activity B ya gatividhi B jo hai vah activity A par nirbhar hai. Doosara tareeka hota hai activity on arrow jisamen ki ham activity A ya gatividhi A jo hai vo is arrow par dikhaate hain aur nodee i aur nodee j is gatividhi ke aarambh aur samaapan ka dyotak hote hain. Isee prakaar activity B ya gatividhi B y aur z nodees ke beech mein hotee hai aur y aur z activity B ya gatividhi B ke aarambh aur usakee samaapti darsha rahe hain. Yadi yahee activities ek ke baad ek kee jaen A aur B, to ham usako is prakaar se dikha sakate hain ki i j ke jahaan par ki activity A jo hai gatividhi A usako ham kahenge ij hai aur activity B jk hai. To jo j node hai vahaan par do cheej ho rahee hai: ek hai activity A ka samaapan aur doosara hai activity B ka aarambh. Ab baat aatee hai is prakaar ke representation kee, yah kya dikha raha hai? Activity A aur activity B ek sang chal rahee hain. Yahaan par jo dikhaaya gaya hai vah yah hai ki activity A samaapt ho jaegee tab activity B shuroo hokar samaapt hogee. Yahaan par activity A aur B ek saath ho rahee hai usamen paraspar nirbharata nahin hai aur activity A i, k hai aur B j, k hai. Dhyaan rahe ki ab nodee k jo hai vah donon hee vidhiyon A aur B ke samaapan ka dyotak hai. Ek aur representation ho sakata hai vo hai is prakaar ka. Jahaan par ki activity A i, j hai aur activity B j, k hai. Yahaan par is nodee se activity A aur activity B donon hee shuroo ho rahe hain aur A ka samaapan nodee j par hai aur B ka samaapan nodee k par hai. Yah to rahee representation kee baat.

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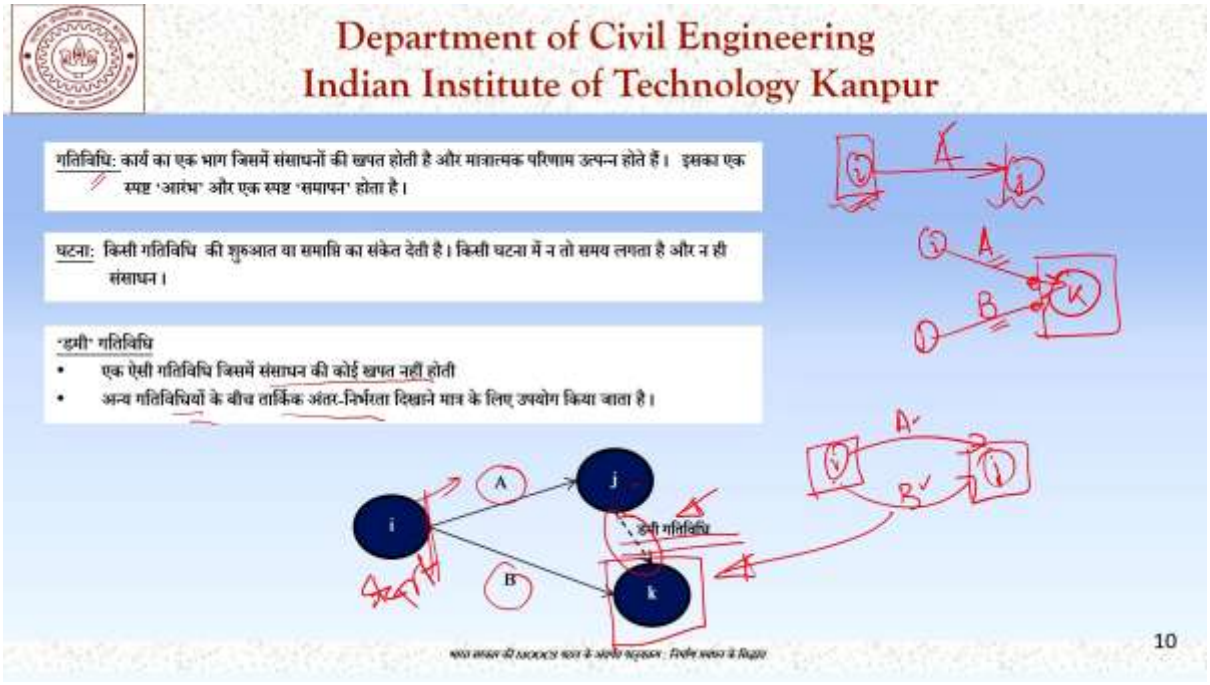
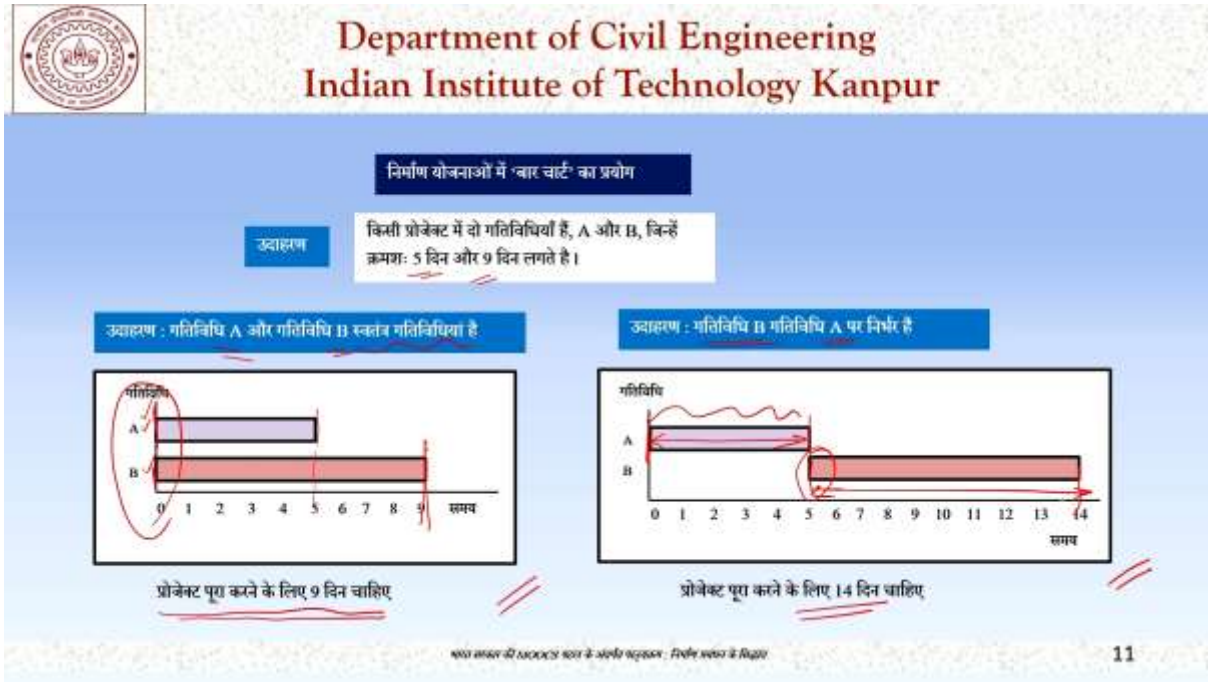


Ab ham aage badhate hain aupachaarik roop se gatividhi kya hai? Gatividhi hai kaary ka ek bhaag jisamen sansaadhanon kee khapat hotee hai aur maatraatmak parinaam utpann hote hain. English mein agar is baat ko kahen to, an activity is a part of a project which involves consumption of resources and has a quantifiable output. Ek maatraatmak parinaam aavashyak hai isaka ek spasht aarambh aur ek spasht samaapan hota hai jaisa ki hamane pahale dekha ki agar ham activity A ko aise dikhaate hain to ye nodee i ek spasht roop se activity A ka aarambh hai aur nodee j activity A ka samaapan hai. Ghatana kisee gatividhi kee shuruaat ya samaapti ka sanket karatee hai. To ek prakaar se yah nodee jo hai vah ek ghatana ke dyotak hain. I par kya ghatana ho rahee hai? A aarambh ho raha hai, A gatividhi Aarambh ho rahee hai. J par kya ghatana ho rahee hai A activity khatm ho rahee hai. Agar hamaara representation is prakaar ka hai jaisa hamane pahale dekha tha ki ik, jk yahaan par A hai yahaan par B hai to nodee k par kya ho raha hai? Nodee k mein do ghatanaen ho rahee hai: ek hai A samaapan aur B ka samaapan. Is baat par ham abhee charcha karenge ki ham kab maanenge ki ham nodee k par pahunch gae hain. Spasht hai ki tabhee hoga jab yah donon conditions satisfied hotee hai arthaat A bhee samaapt ho jae aur bhee B samaapt ho jae tabhee ham kah sakate hain ki ham nodee k par pahunch gae hain. Is baat ka ham log prayog karenge network analysis mein jis par ki ham aaj charcha karenge. Ek dummy activity hotee hai. Dummy gatividhi kya hota hai? Ek aisee gatividhi jisamen ki sansaadhan kee khapat nahin hotee hai. Gatividhi mein yah paribhaashit hai ki usamen sansaadhanon kee khapat hogee. Dummy activity mein sansaadhanon kee khapat nahin hotee hai, to phir isakee aavashyakata kyon hotee hai? Any gatividhiyon ke beech taarkik antarnirbharata dikhaane maatr ke lie isaka upayog kiya jaata hai.

Aaiye isako ham ek udaaharan mein dekhate hain. Agar is prakaar ka network hai to i j hamaaree activity A hai aur i k hamaaree activity B hai agar us project mein maatr do hee gatividhiyaan hai/do hee activity hain to ab hamaara project kab khatm hoga? Ek spasht start to yahaan par mil gaya, yah node A aur B donon ka aarambh dikha raha hai lekin jis prakaar se ham dikhaana chaahate hain kee node k par pahunchane par hee hamaara project samaapt hoga. To ham j aur k ko ek tareeke se short sarkit karate hain aur ek dotted arrow se isako dikhaate hain isako ham kahate hain dummy gatividhi kyonki agar hamaaree do activities hain A aur B, to ham i aur j aise nahin kar sakate hain ki i aur j donon A aur B donon ke hee starting point aur end point ek ho isamen confusion hota hai ye nahin allowed hai. Isako ham is prakaar se break karate hain todate hain to j ko ham tod dete hain aur j aur k lagaate hain

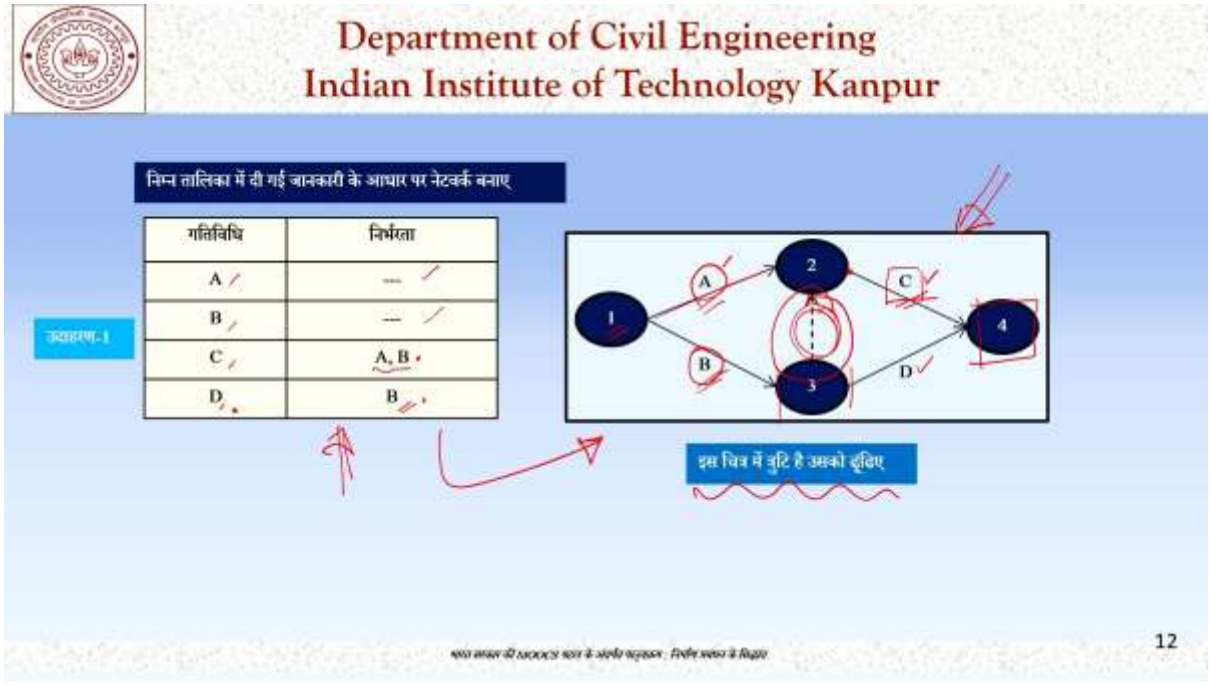
aur j aur k ke beech mein dummy gatividhi lekar ke ham bataate hain ki hamaara project k par pahunchane par samaapt ho jaega.

(Reference Time 08:39)



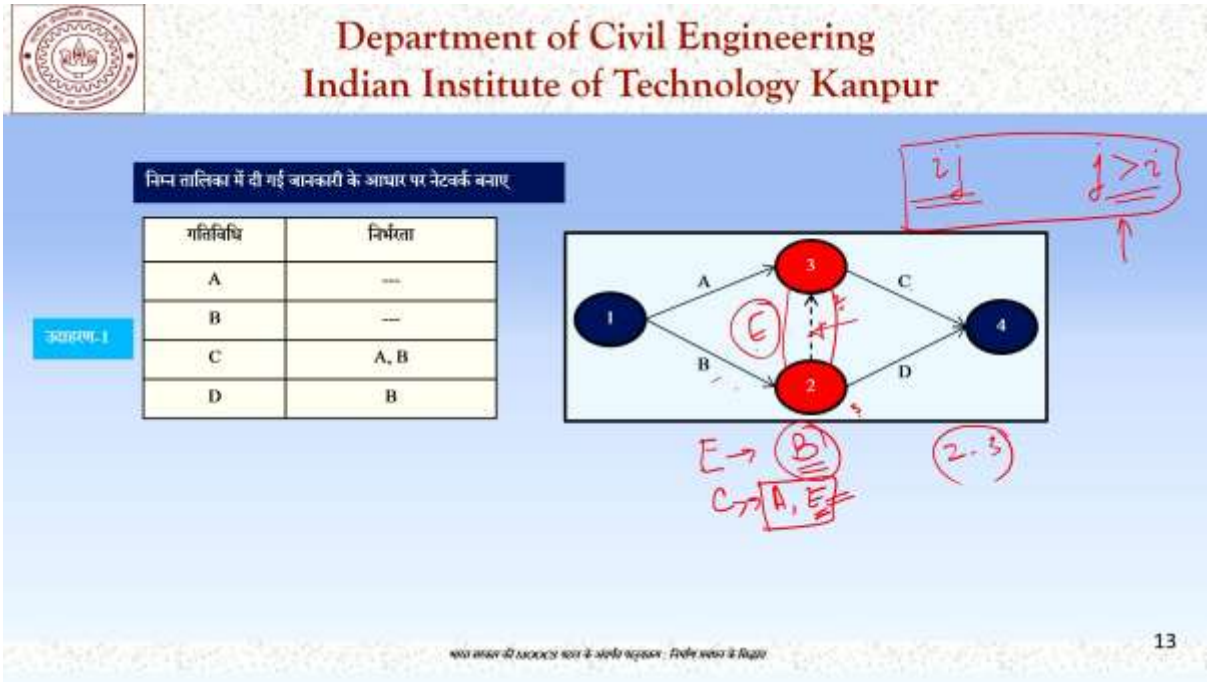
To aaiye aage badhate hain aur dekhate hain nirmaan pariyojanaon mein bar chart ka upayog. Ek udaaharan lete hain aise project ka jahaan par ki A aur B do hee activities hain aur kramashah unamen 5 din aur 9 din lagate hain. To bar chart par agar ham dekhate hain to do extreme representation hai. Ek hai jisamen ki gatividhi A aur B svatantr hai, vah ek doosare par nirbhar nahin hai. To ham project kee shuruaat mein hee A aur B donon hee shuroo kar sakate hain. Ab A kyonki 5 din mein khatm ho jaegee, to yah to yahaan khatm ho jaegee. B mein 9 din lagenge to vo 9 din tak chalegee. To isamen project ko poora karane ke lie hamen 9 din kee aavashyakata hotee hai. Dhyaan rahe ki hamane yah maan liya hai ki kyonki A aur B svatantr gatividhiyaan hai aur ek doosare par nirbhar nahin hai to ham A ko bhee jab shuroo kar sakate hain arthaat project kee shuruaat mein hee to vaheen par isako shuroo kar dete hain. Doosaree sthiti tab utpann hotee hai jabaki gatividhi B gatividhi A par nirbhar hai tab kya hoga? Ham gatividhi B ko yahaan par shuroo hee nahin kar sakate ham tabhee gatividhi B shuroo kar sakate hain jab gatividhi A samaapt ho jae arthaat project kee shuruaat mein maatr activity A hee ho sakatee hai. To pahale 5 din gatividhi A chalegee aur jab ye samaapt ho jaayegee tab gatividhi B chalegee aur hamen project poora karane ke lie 14 din ka samay lagega. Yah bar chart ka representation hai.

(Reference Time 10:27)



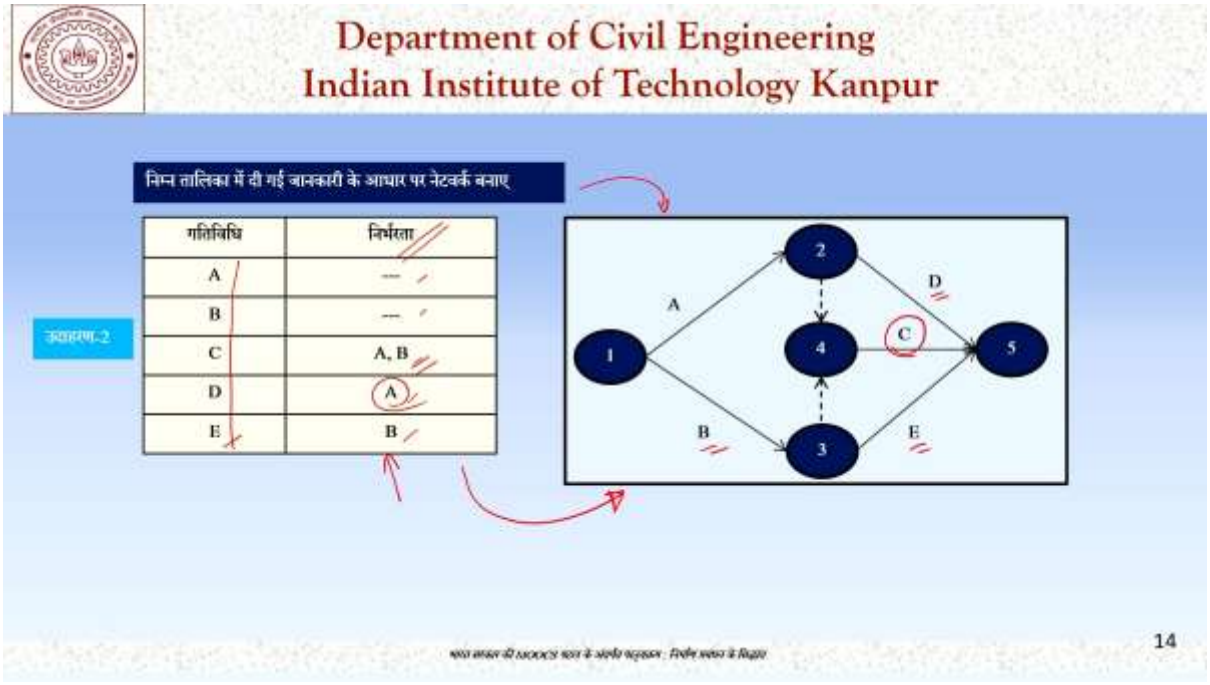
Aaiye ab ham ek udaaharan se kuchh network banaane kee koshish karate hain. Is taalika mein diya hua hai ki hamaare project mein chaar gatividhiyaan hain A, B, C aur D. A aur B koee nirbharata nahin hai arthaat vo ek sang shuroo kee ja sakatee hai project mein. C, A aur B donon par hee nirbhar hai aur D keval B par nirbhar hai arthaat C tabhee shuroo ho sakatee hai jab A aur B donon samaapt ho jae, jab ki D shuroo ho sakatee hai jabaki keval B samaapt ho jae. A aur B ek sang shuroo mein hee shuroo kee ja sakatee hai. To is baat ko ham network mein kaise le jaate hain network hamane banaaya is tareeke se jahaan par ki activity A aur B hamane node 1 se shuroo kiya aur shuroo mein hee activity A aur activity B is prakaar se kee aur C banaane ke lie yah darshaana aavashyak tha ki vah A aur B donon par hee nirbhar hai. Yah hamane kaise dikhaaya? Ye dummy activity use karake. Is dummy activity ka matalab yah hua ki arrow kyonki is tareeke se pointed hai to C tabhee shuroo ho sakatee hai jabaki A aur B donon pooree ho jae. Kyonki yahaan par sansaadhan kee khapat nahin ho rahee hai isalie ek tareeke se node 3 par pahunchana aur node 2 par pahunchana is raaste se ek hee baat hai inako alag kiya gaya hai maatr logical kaaranon se/ek taarkik kaaran se inako alag kiya gaya hai. To C to ho gaya, A aur B donon par nirbhar to C yahaan dikha diya gaya. D kyonki maatr B par nirbhar hai isalie D B kee samaapti par shuroo hua aur yahaan par samaapt ho gaya. To hamane node 4 ko maan liya hamaare project ka samaapan. Project ka samaapan kab hua jabaki activity C aur activity D donon hee pooree ho gaee. To is prakaar se hamane is network mein is taalika mein dee huee jaanakaaree ko tabdeel kar diya usako represent kiya ab ek chhotee see isamen truti kee gaee hai jaanaboojhakar ke. Main chaahata hoon ki aap log dhyaan se is network ko dekhen aur pakadane kee koshish karen ki galatee kahaan hai?

(Reference Time 12:52)



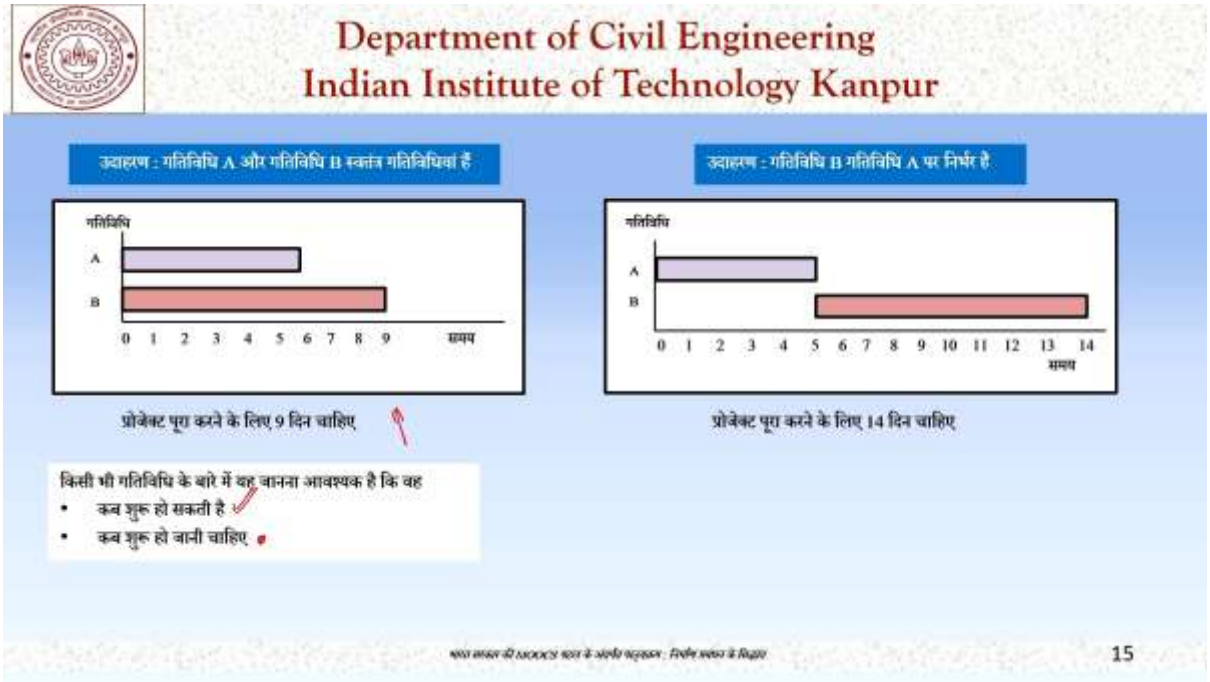
To galatee ye hai. Hamane pahale bataaya tha ki jab ham activity ko ij karate hain to hamesha koshish yah karanee chaahie ki j i se bada ho. To ham jab activity 2-3 kar rahe the jo yahaan par 2-3 dikhaaya gaya hai vahaan par vah 3-2 tha hamane is node ko teen maana tha aur is node ko 2 maana tha. To jo dummy activity thee vahaan par vah dummy activity thee. Jo dummy activity thee vah 3-2 ho gaee thee jabaki is niyam ke anusaar vah 2-3 honee chaahie thee kya ho sakatee hai to agar ham isako 2-3 kar denge to activity A ho gaee 1-3, activity B ho gaee 1-2 aur dummy activity ho gaee 2-3. To is prakaar se sabhee activities mein yah jo ek condition hai vah satisfy ho rahee hai yah hamesha dhyaan mein rakhana chaahie. Yah bhee ho sakata hai ki antatah kisee bhee project mein yah dummy activity na ho; ek aur activity ho jo ki ho sakata hai ai ham maane aur E mein kuchh sansaadhan lage aur yah kaha jae ki E B par nirbhar hai aur C A aur E par nirbhar hai. Seedhee see baat yah hai ki jab ham kahenge ki C, A aur E par nirbhar hai to B par nirbharata, C kee B par nirbharata usamen samaavesh hota hai kyonki E B par nirbhar hai, C E par nirbhar hai. To obviously C B par bhee nirbhar hai arthaat C karane ke lie na sirph B balki E bhee pooree ho jaanee chaahie aur us case mein yah niyam ki E ko ham 2-3 kahen vah bahut mahatvapoorn ho jaega. Isalie node kee numbering karate vakt unako/number assign karate vakt vishesh dhyaan rakhana chaahie.

(Reference Time 14:54)



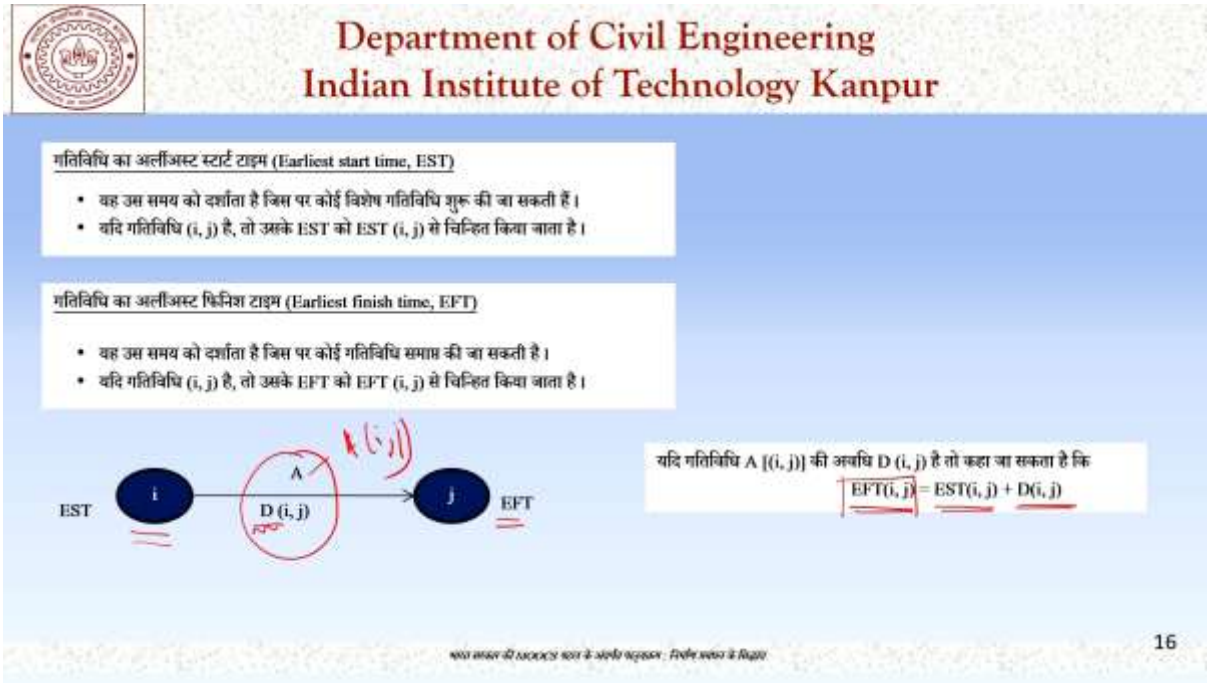
Aaiye ek aur udaaharan dekhate hain jahaan par ki hamaare pass A, B, C, D, E yah paanch activities hain. Jahaan par nirbharata A aur B svatantr hain, C A aur B par nirbhar hai, D A par aur E maatr B par. To isako hamane represent kiya is prakaar ki A aur B shuroo ho gae phir E par aur B donon par hee C nirbhar ho gaee jo ki yahaan par diya hua hai aur E B se aa gaya jo yahaan diya hua hai aur D shuroo huee jabaki A samaapt ho gaee. To is prakaar kee taalika se is prakaar ka network banaana yah ek bahut mahatvapoorn kadam hota hai aur main chaahoonga ki aap log isakee practice avashy karen. Dhyaan rahe ki yahaan par maatr nirbharata kee baat ho rahee hai abhee tak hamane donon udaaharanon mein avadhi kee baat nahin kee hai ki activity A hai, ya B hai, C hai jo bhee hai vah kitane din kee hai ya kitane saptaah lagenge isakee baat abhee nahin huee hai arthaat project kee avadhi kya hogee kya nahin hogee is par hamane bhee charcha nahin kee hai aur us baat ko ham abhee introduce karenge.

(Reference Time 16:07)



Aaiye ab ham log baat karate hain avadhi ko jodane kee, gatividhiyon mein avadhi ko jodana hai. Hamane pahale udaaharan mein dekha tha ki do gatividhiyaan thee A aur B jinamen ki 5, 3 ya 9 din lagate hain aur usamen svatantr hone par hamen project ke lie 9 din chaahie aur gatividhi B agar A par nirbhar hai to hamen 14 din lag rahe the. Ab do baaten bahut spasht roop se samajh lenee chaahie ki kisee bhee gatividhi ke lie do samay hote hain: ek samay vah hota hai jabaki vah gatividhi nirbharata ke aadhaar par shuroo kee ja sakatee hai. Doosara samay vah hota hai jabaki vah gatividhi aavashyak roop se shuroo kar dee jaanee chaahie. Yadi vah shuroo nahin kee jaatee hai to hamaara project delay ho jaega usakee avadhi badh jaegee. Is baat ko ham is chitr mein kaise dekh pa rahe hain? Activity A hai jo ki 5 din mein samaapt ho jaegee. Activity B hai jisake lie 9 din lagenge. To yah aavashyak nahin hai ki a 0 par hee shuroo kee jae ham usako 4 din par bhee shuroo kar sakate hain aur agar 5 din lagate hain to 9 din mein vah samaapt ho jaegee arthaat hamaara project jisamen ki vaise bhee 9 din lagane vaale hain ham B to karen shuroo se lekin A karane mein thoda sa gunjaish hai ek thoda sa hamaare pass flexibility hai ki ham usak 0 par shuroo karenge, to 5 par khatm ho jaegee aur nahin to hamen 4 par to aavashyak roop se usako shuroo kar dena hee chaahie kyonki agar hamane 4 par bhee shuroo nahin kiya tab hamaara project 9 din kee bajaay ho sakata hai 10 din ya 11 din chala jae. To kisee bhee gatividhi ke lie yah samay aur yah samay alag-alag ho sakate hain. Is baat ka udaaharan aur is baat kee charcha ham log lagaataar aaj ke lecture mein karenge.

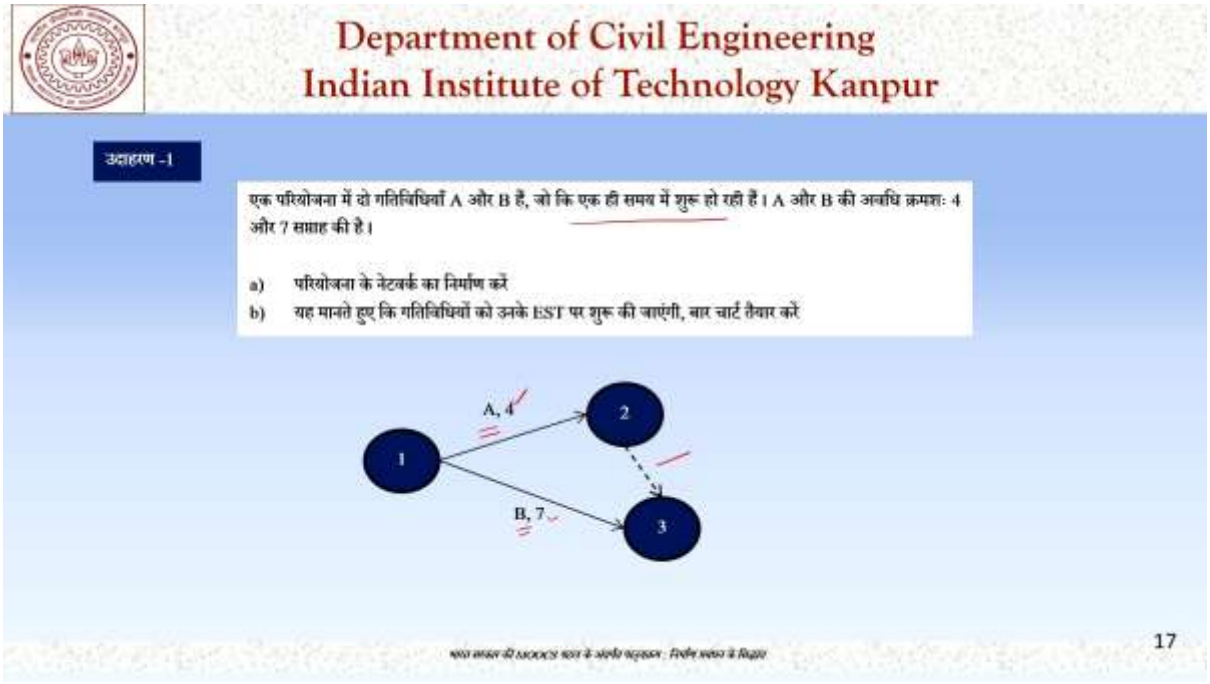
(Reference Time 18:17)



To aaiye aupachaarik roop se dekhate hain ki Earliest starting time (EST) kya hota hai? Earliest starting time kisee bhee gatividhi ke us samay ko darshaata hai jis par ki vishesh gatividhi shuroo kee ja sakatee hai arthaat jo gatividhiyaan usake pahale pooree honee chaahie vah ho gaee hain aur yah gatividhiyaan nirbharata ke aadhaar par shuroo kee ja sakatee hain. Yah hota hai us gatividhi ka earliest starting time arthaat usake pahale to yah gatividhi shuroo kee hee nahin ja sakatee. Yadi gatividhi ij hai to usaka EST(ij) se chinhit kiya jaata hai. Gatividhi ka earliest finish time bhee hota hai, earliest finish time kya hua? Yah us samay ko darshaata hai jis par gatividhi samaapt kee ja sakatee hai. Hamane earliest starting time maana jabaki gatividhi shuroo ho sakatee hai. Earliest finish time kya hoga? Gatividhi ke shuroo hone ke baad us gatividhi mein lagane vaalee avadhi ko agar ham usamen jod denge to ham pahunch jaayenge earliest finishing time par (EFT). Yadi gatividhi i j hai to usaka EFT, EFT(ij) se chinhit kiya jaata hai. Yahaan par dikhaaya gaya hai ki agar

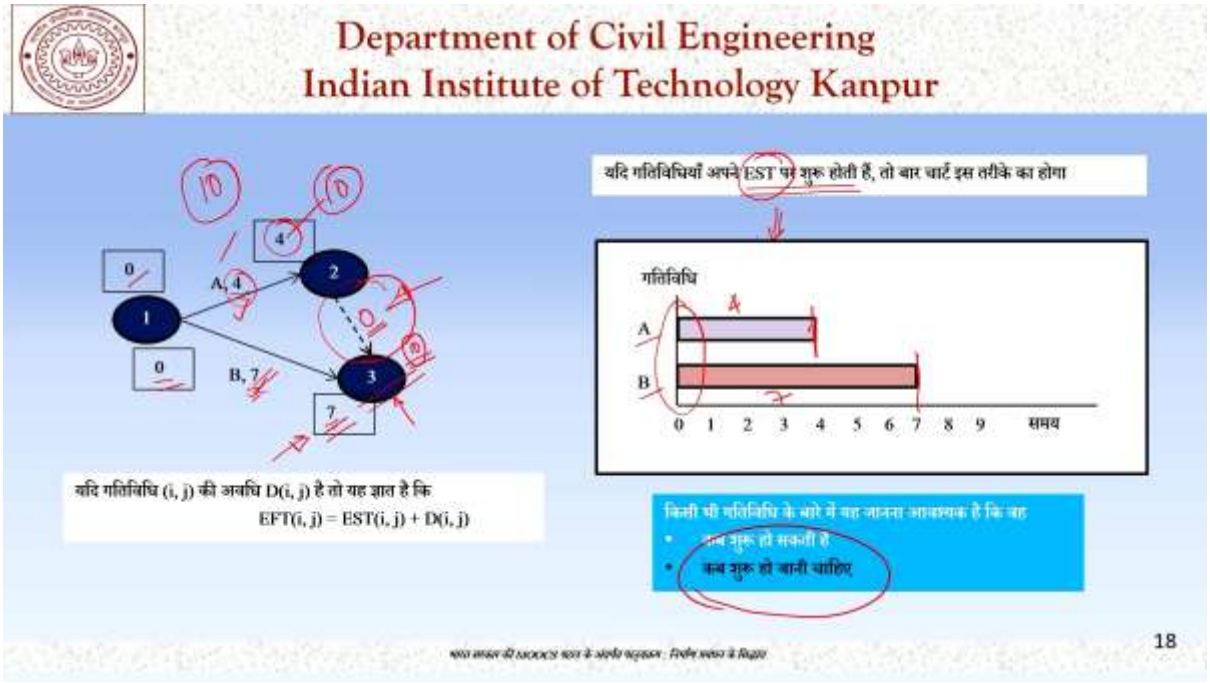
activity A jisaka ki duration D(ij) hai, activity Aij hai aur usaka duration D(ij) hai yah i usaka earliest starting time hai aur j usaka earliest finish time hai. To earliest finish time jo hai i j ka arthaat gatividhi A ka vah usake earliest starting time plus usaka duration, is prakaar ham pahunch jaate hain earliest finish time par. Aaiye is baat ko ham ek udaaharan ke maadhyam se dekhate hain.

(Reference Time 20:16)



Ek pariyojana mein do gatividhiyaan hain A aur B jo ki ek hee samay par shuroo ho rahee hai. A aur B kee avadhi kramashah 4 aur 7 saptaah kee hai to pariyojana ke network ka nirmaan karen aur yah maanate hue ki gatividhiyon ko unake EST par shuroo kiya jaega bar chaart banaen. To network bilkul clear hai ki hamaaree activity hai A jo ki 4 saptaah letee hai activity B hai jo ki 7 saptaah letee hai, donon independent hai ek hee samay par shuroo hotee hain to hamane node i se usako shuroo kiya 1 maana usako, 1-2 aur 1-3 aur kyonki do hee activity ka project hai to yahaan par hamane isako ek dummy activity se jodakar project samaapt kar diya.

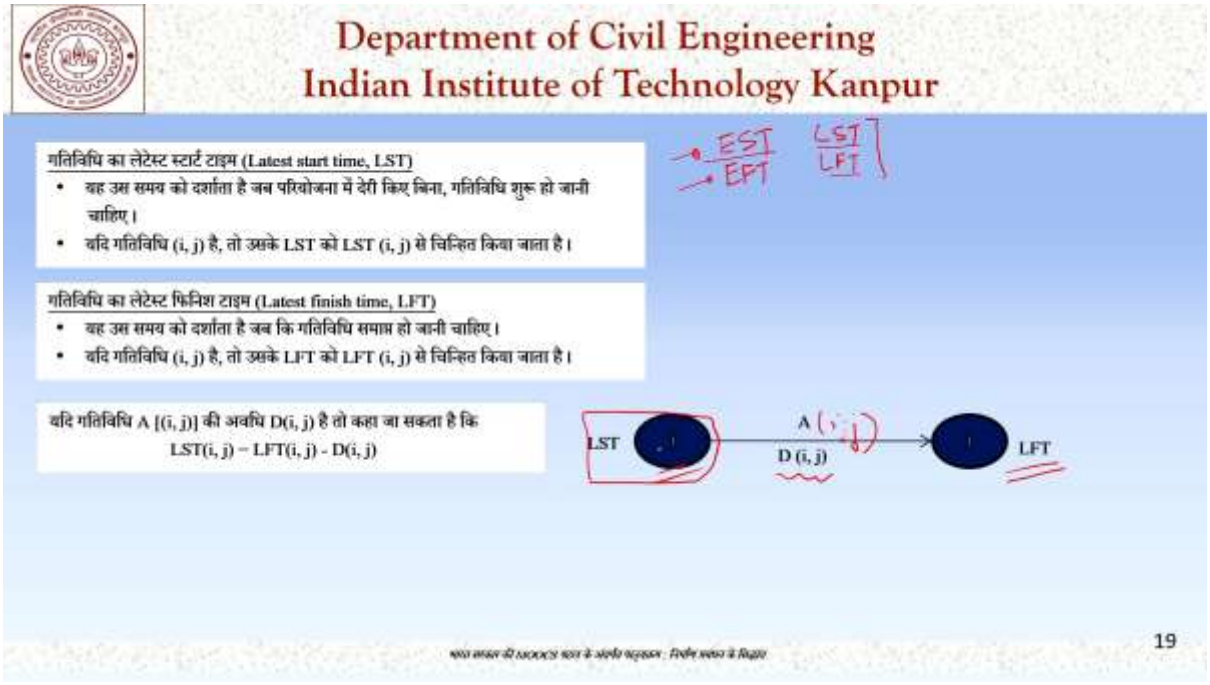
(Reference Time 21:02)



Is baat ko agar ab ham bar chart ke roop mein dikhaenge. To ham dikhaenge kee activity A aur B donon 0 se shuroo huee aur yah activity to yahaan 4 par khatm ho gaee aur yah activity 7 saptaah tak chalee. Yah baat tab kee hai jabaki gatividhiyaan EST par shuroo ho rahee hai. A, EST kya hai? Zero, A turant shuroo kiya ja sakata hai kyonki vah B par nirbhar nahin hai. To A aur B hamane EST par hee shuroo kiya donon ka EST 0 tha aur jahaan pe isakee duration thee isakee 4 week thee, isakee 7 week thee to inaka EFT hamane yahaan nikaal liya.

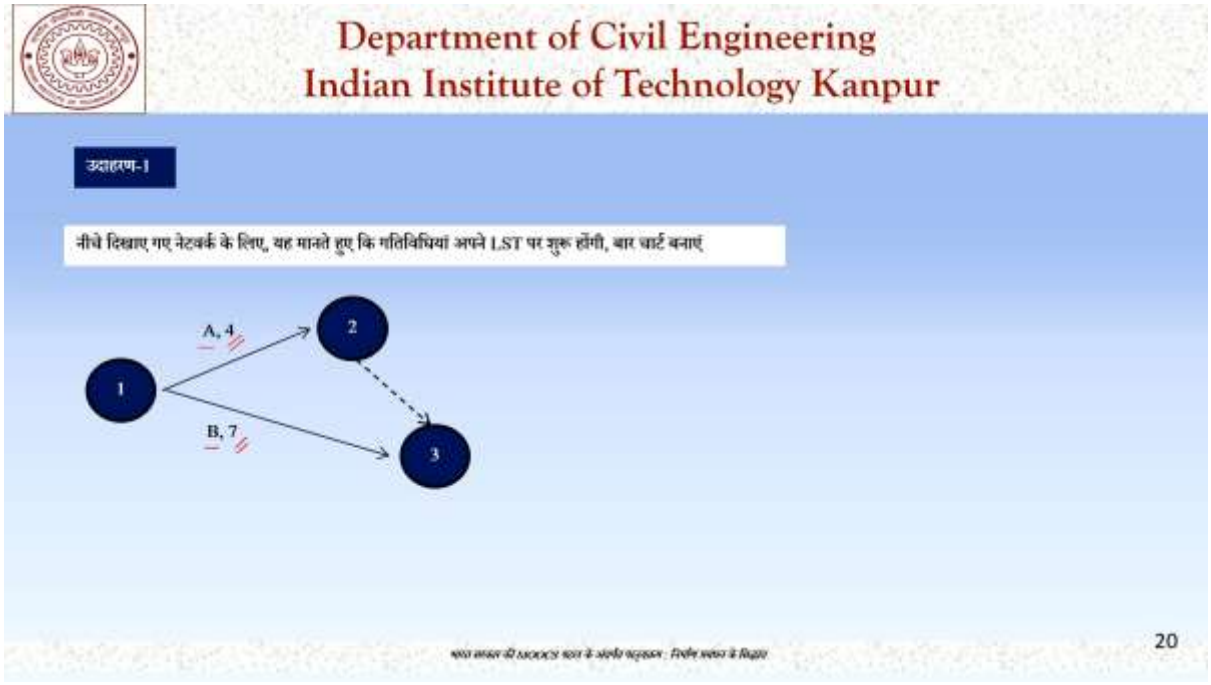
Usako hamane yahaan par represent kiya ki 0 par hamane yah bhee shuroo kiya 0 par hee hamane yahaan par shuroo kiya aur A ham pahunch gae 4 par kyonki hamaaree gatividhi kee duration 4 saptaah thee. Yahaan par is activity kee duration 7 saptaah thee to ham yahaan 7 par aa gae. Dhyaan is baat ka rakhana hoga ki hamaare pass yah dummy activity hai jo ki hamako yah chetaavanee de rahee hai ki yahaan par aap maatr B poora karane se hee nahin pahunchenge, aapako A bhee samaapt karana hai. To is udaaharan mein to yah baat ban jaatee hai kyonki yah avadhi isase kam thee, agar kal ko E mein 10 din lag rahe hote ya 10 saptaah lag rahe hote hain; tab ham is node par kab pahunchate? Ham pahunchate yahaan se 7 aur yahaan se 10 to yah ho jaata 10 aur is 10 se kyonki is dummy activity mein to duration 0 hai, to yahaan se pahunchane mein hamako lagata 10. To is 10 aur is 7 mein jo bhee bada hoga maximum of 10 aur 7 tabhee ham is node par pahunch sakenge. To hamaare project kee duration 7 nahin hogee 10 hogee aur vah kisase gavarn hogee? Activity A se. To ye to isakee ek corollary thee jo ham logon ne example liya hai jo udaaharan diya hai usamen to baat 4 aur 7 kee hai isamen jo number die hue hain ham unaka maan sakate hain. Ab abhee hamane is baat kee charcha nahin kee hai ki kaun see activity kab shuroo ho jaanee chaahie. Kis activity ko kab aavashyak roop se shuroo kar diya jaana chaahie.

(Reference Time 23:37)



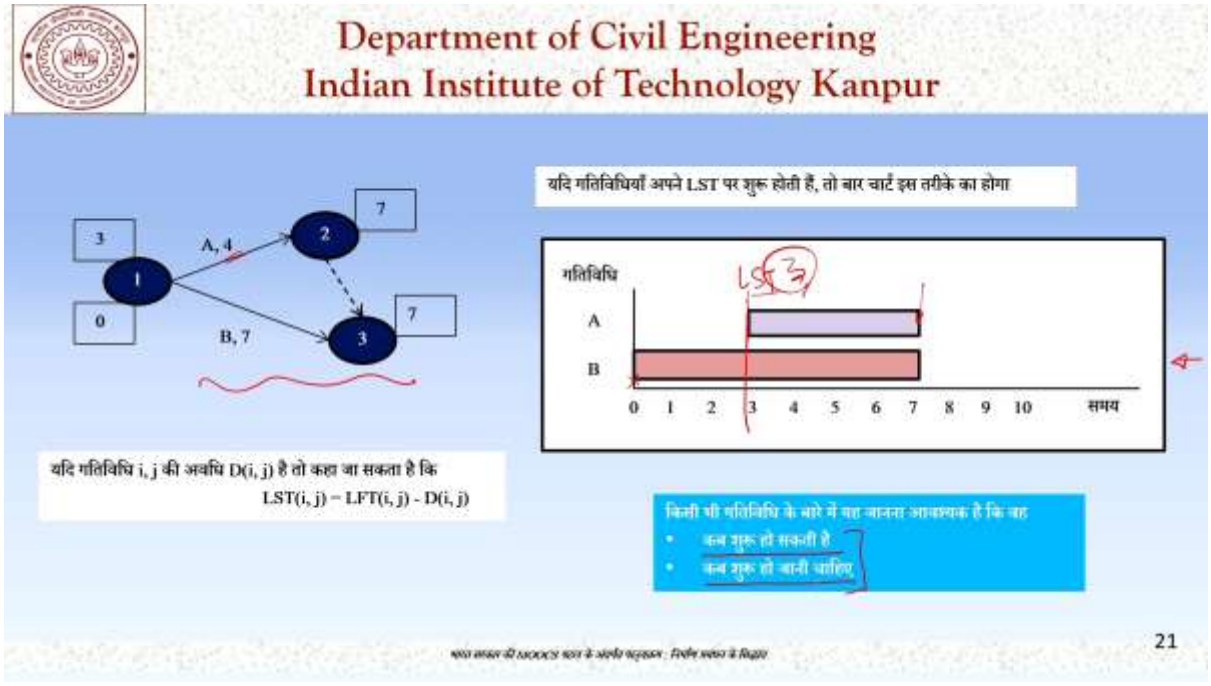
Yah baat hai latest start time kee. Latest start time kya hota hai kisee gatividhi ka? Yah kisee bhee gatividhi ke us samay ko darshaata hai jab pariyojanaon mein deree kie bina gatividhi shuroo ho jaanee chaahie. Yadi gatividhi i j hai to LST arthaat latest starting time ko LST(ij) se chinhit kiya jaata hai. Usee prakaar gatividhi ka latest finish time bhee hota hai jisako ki ham LFT kahate hain aur LFT us samay ko darshaata hai jabaki gatividhi samaapt ho jaanee chaahie. Gatividhi ij hai to usaka LFT(ij) se chinhit kiya jaata hai. To hamane chaar terms dekhe ek tha EST (Earliest start time), Earliest finish time, latest start time aur latest finish time. Earliest start time vo hai jabaki koee gatividhi shuroo kee ja sakatee hai. Earliest finish time vo hai jabaki koee activity kab samaapt kee ja sakatee hai. LST ya latest start time vo hai jab hamen koee activity anivaary roop se shuroo kar denee chaahiye aur LFT vah samay hai jabaki anivaary roop se vah activity samaapt ho jaanee chaahiye. To in 4 terms ko dhyaane mein rakhiye kisee bhee vishleshan mein. To yadi gatividhi Aij hai jisakee ki avadhi D(ij) hai, to ye kaha ja sakata hai ki LST(ij) is equal to LFT(ij) minus D(ij) arthaat jo latest start time hai is gatividhi ij ka, vah kya hai? LFT jo ki latest finish time hai usamen se agar ham D(ij) ghata den to ham pahunch jaenge latest starting time par. To vah cheej mathematical equation ke roop mein yahaan dikhaee gaee hai.

(Reference Time 25:37)



To aaiye ham ek udaaharan dekhate hain aur neeche die gae network mein yah maanate hue ki gatividhiyaan apane LST par shuroo hogee bar chart banaane ka prayaas karate hain. To udaaharan vahee hai activity A aur activity B jabaki activity A mein lag rahe hain 4 saptaah aur activity B mein lag rahe hain 7 saptaah.

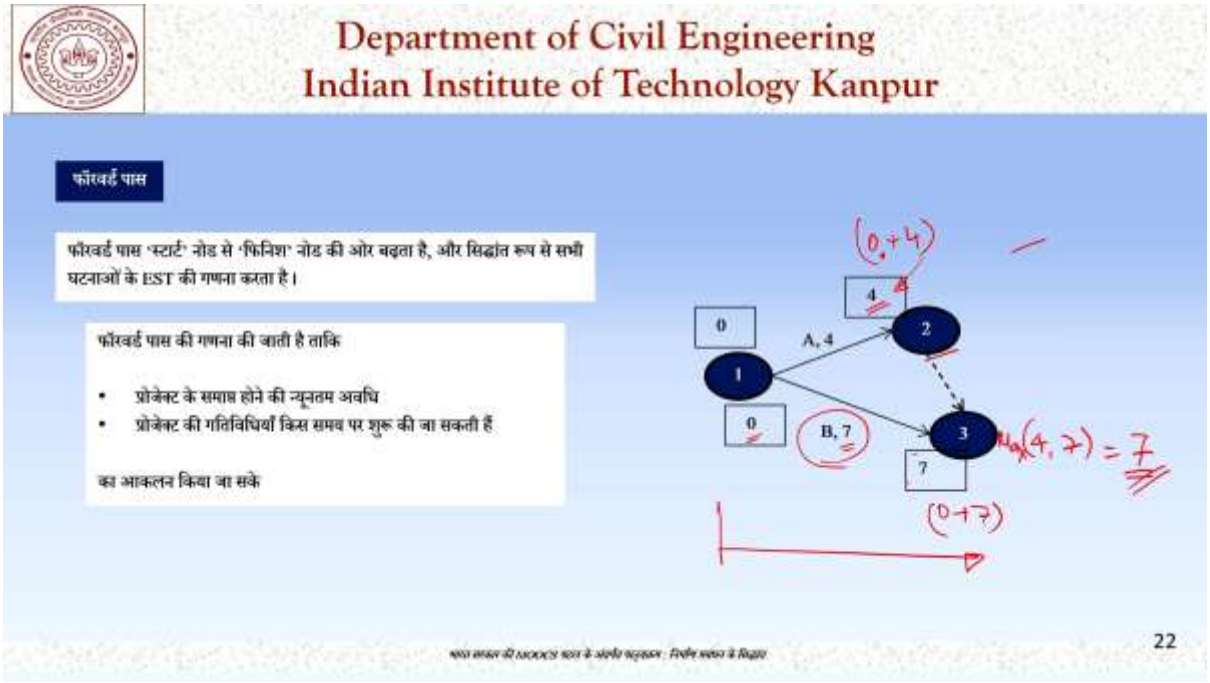
(Reference Time 25:57)



To agar ab ham yah maanate hain ki yahaan par activities ya gatividhiyaan LST arthaat latest starting time par shuroo hotee hain, to bar chart is prakaar ka banega arthaat hamaaree activity B jo ki shuroo hogee 0 se 7 mein khatm ho jaegee aur kyonki project kee duration 7 hai vah hamane yahaan par dekha hai kyonki duration 7 hai to isalie kam se kam us samay A bhee samaapt ho jaanee chaahie aur kyonki A kee avadhi 4 hai to latest start time jo activity A ka hai vo hai 3. To is point par activity A aavashyak roop se anivaary roop se shuroo kar dee jaanee chaahie yah fark hai in donon bar chart mein. Ab hamane activity kab shuroo ho sakatee hai aur kab shuroo ho jaanee chaahie in donon ka phark bahut hee spasht roop se

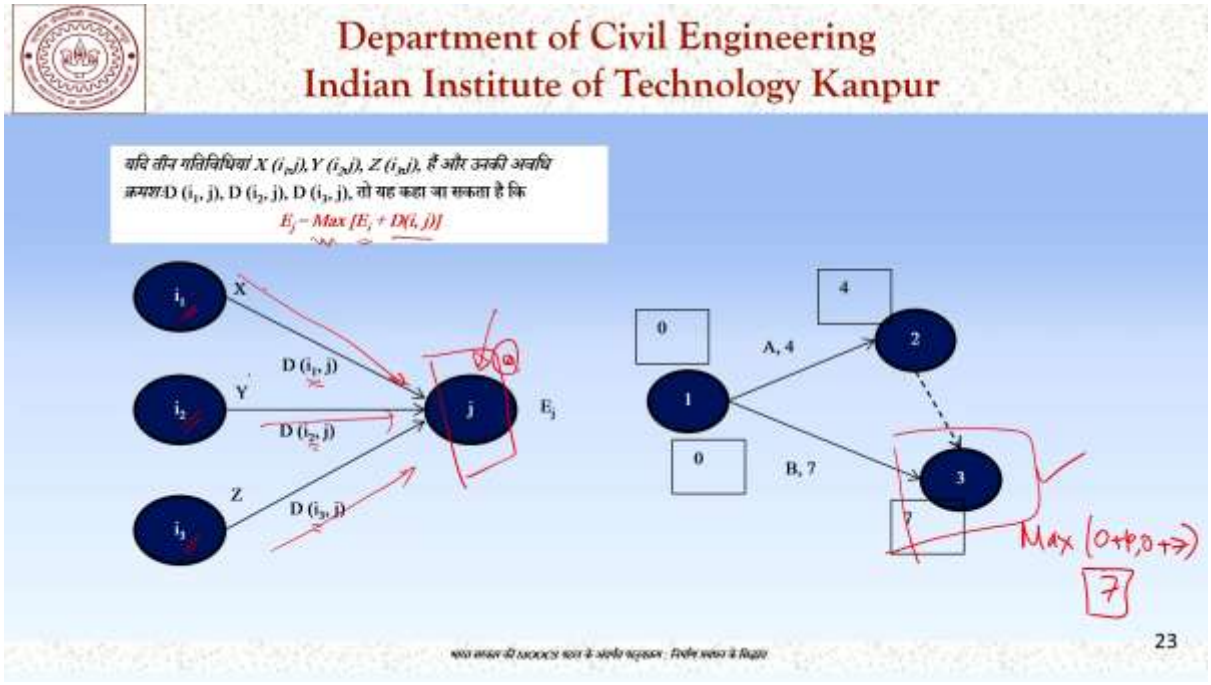
aapako dikhaaya hai. Is baat ko agar ek bade network mein jab ham baat karate hain tab ham usako forward pass aur backward pass in do system se determine karate hain.

(Reference Time 27:12)



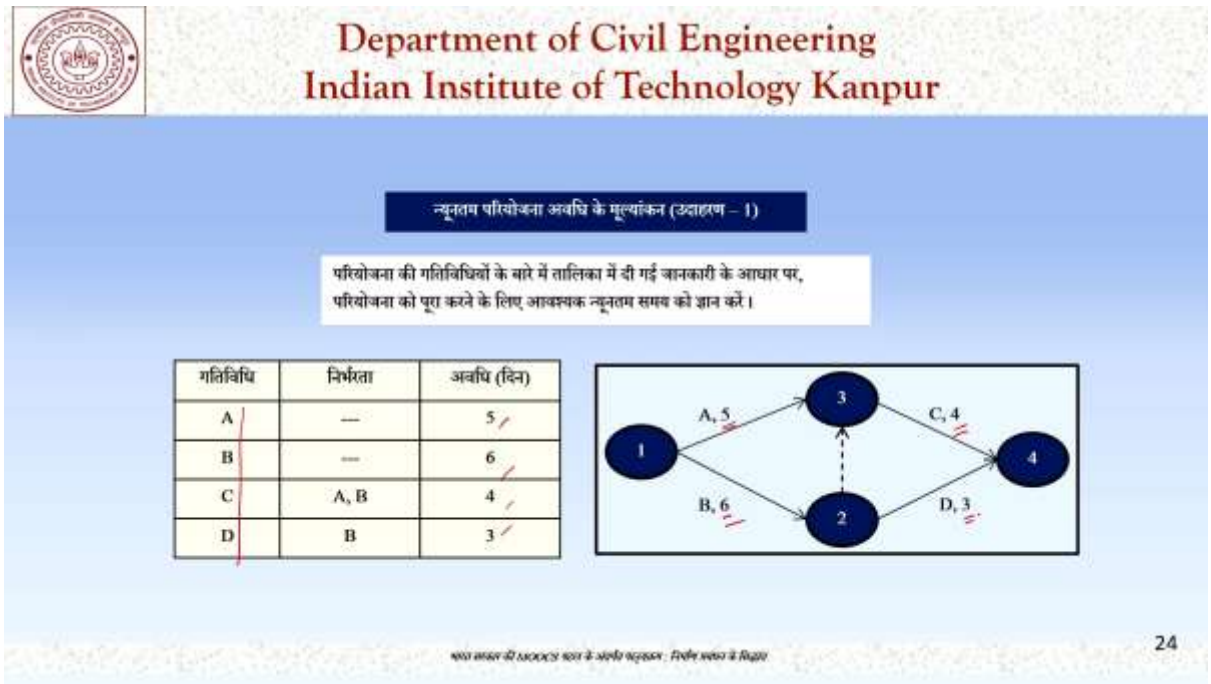
Forward pass kya hota hai? Forward pass start node se finish node kee or badhata hai aur siddhaant roop se sabhee ghatanaon ke EST kee ganana karata hai. Forward pass kee ganana kee jaatee hai taaki project ke samaapt hone kee nyoonatam avadhi tay kee ja sake, nirdhaarit kee ja sake, pata kee ja sake aur project kee gatividhiyaan kis samay par shuroo kee ja sakatee hain isakee jaanakaaree hamen mil sake. To agar ham pichhale udaaharan ko lete hain aur is network mein forward pass karate hain to yah calculation hamane aapako pahale bhee bataaya tha ki ham node 2 par pahunchenge 0 plus 4 karake kyonki yahaan par ek hee arrow aa raha hai to 0 plus 4 to yah ham likh dete hain 4. Yahaan par ham likh rahe hain earliest finish time for A aur jaahir see baat hai ki isaka earliest finish time is activity ka jo ki dummy hai isaka earliest starting time bhee hoga. Ab activity B par aate hain to hamane agar activity 0 par shuroo kee to ham yahaan par 0 plus 7 arthaat EST(ij) isaka 0 plus isaka duration 7 to yahaan aa gaya 7 aur yahaan par maximum of 4 end 7 is equal to 7. To yah hamaara project ka duration aa gaya 7. To ham logon ne kiya forward pass arthaat start se end aur kee or ham chale aur project kee avadhi nirdhaarit kee, gyaat kee. Ham 7 din se pahale yah project khatm nahin kar sakate hain kyonki isamen ek activity aisee hai jisamen ki 7 din to lag hee rahe hain.

(Reference Time 29:00)



Ab agar teen gatividhiyaan hain ek X (i_1, j), Y (i_2, j), Z (i_3, j) jo ki dikhaee gaee hain is prakaar. X, Y aur Z teen activities hain jo ki j par samaapt ho rahee hai aur inaka starting point ya starting node i_1, i_2 aur i_3 hai to arthaat X ka starting point i_1 hai, Y ka staart i_2 hai aur Z ka start i_3 hai. Inake durations d(i_1, j), d(i_2, j) aur d(i_3, j) hain to yahaan par pahunchane ka samay hoga maximum of E_i plus D(ij) arthaat is route se jo number aaega, is route se jo number aaega aur is route se jo number aaega usaka maximum hoga yahaan par pahunchane ka samay. Ye cheej hamako yahaan par spasht dikh rahee hai jahaan par ki do arrows milake aa rahe hain aur maine aapako pahale bataaya ki ham yahaan par lenge maximum of 0plus4 aur 0 plus 7 arthaat 7.

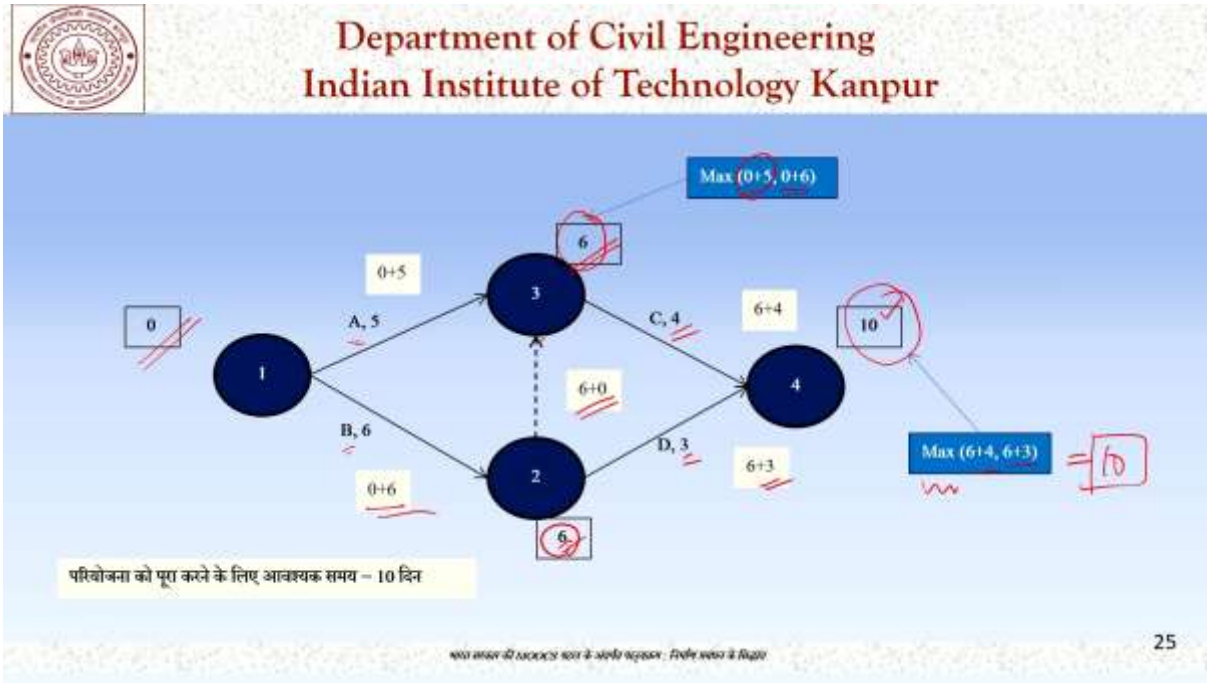
(Reference Time 30:24)



Aaiye is cheej ko ham log ek aur udaaharan ke maadhyam se samajhate hain ki pariyojana kee gatividhiyon ke bare mein taalika mein dee gaee jaanakaaree ke aadhaar par pariyojana ko poora karane ke lie aavashyak nyoonatam samay gyaat karen. To agar activity 4 hain A,

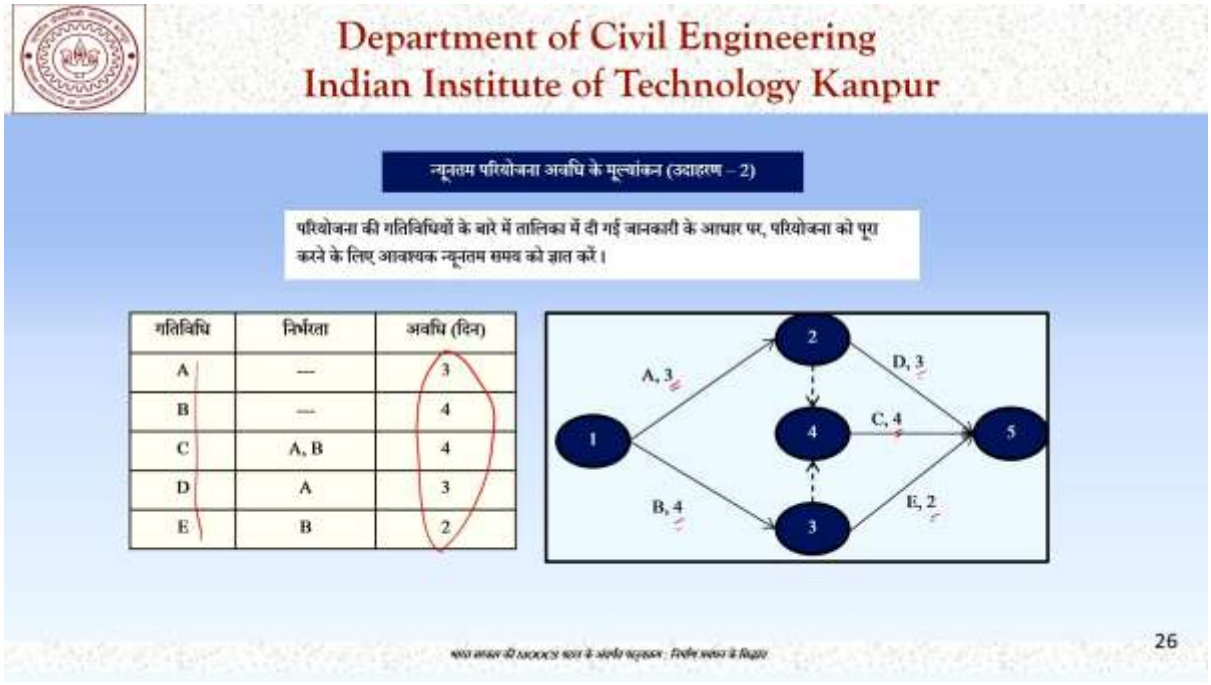
B, C, D, aur inakee avadhi is prakaar se dee huee hai dipendens diya hua hai, to yah network to ham pahale bana chuke hain sirph isamen hamane gatividhiyon ka samay jod diya hai. To ab tay yah karana hai ki yah project poora karane ke lie hamen kitana samay lagega?

(Reference Time 30:55)



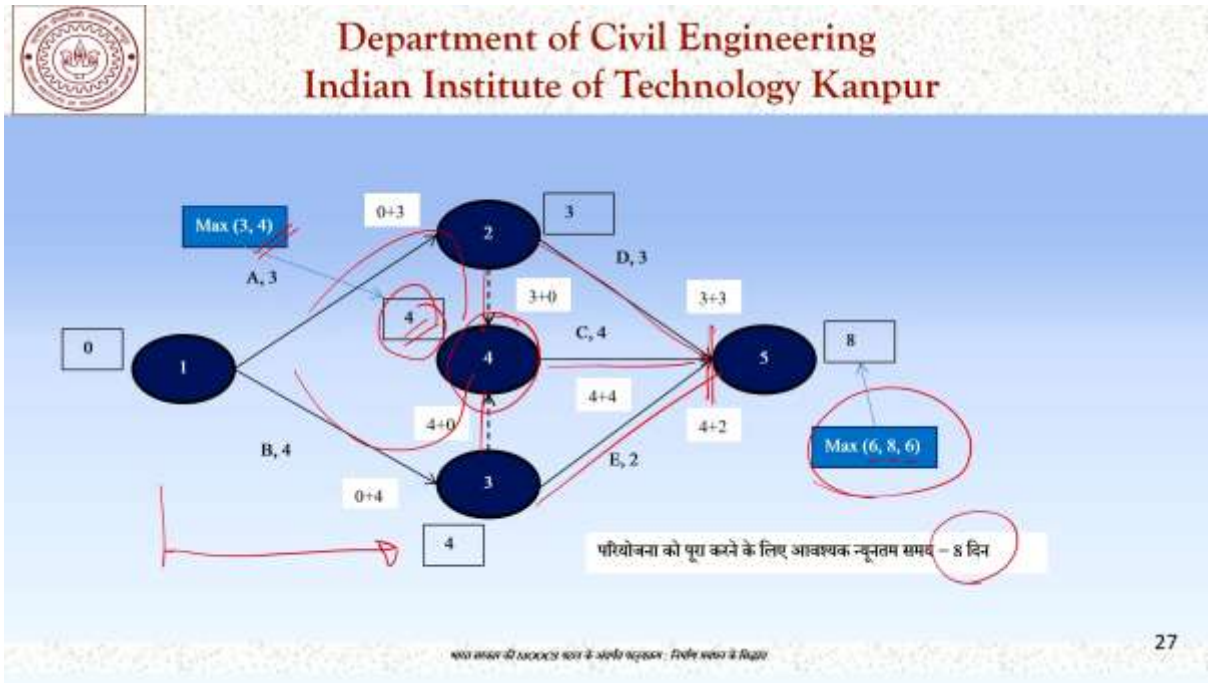
Samay kee calculation is chitr mein dikhaee gaee hai. Ham 0 par activity shuroo kar sakate hain kyonki A aur B donon independent hai to ham ek saath unako shuroo karate hain EST par donon activity shuroo hongee A aur B. Yahaan se pahunchenge 0 plus 5 lekin yahaan par doosara arrow bhee aa raha hai usakee pahachaan karane ke lie ham dekhenge ki ham aa kahaan se rahe hain? Yah arrow aa raha hai yahaan se, to ham B ko dekhate hain ki yahaan ham pahunchenge 0 plus 6 arthaat 6 aur yahaan par pahunchenge is route se 6 plus 0 se to arthaat 0 plus 6 aur 0 plus 5 isaka maximum lenge to yahaan par ham pahunchenge 6 par. Aur jab ham yahaan pahunchenge 6 par, to yahaan ham kab pahunchenge jo ki hamaara project samaapt ho raha hai? Yahaan ham pahunchenge 6 plus 4 arthaat 10 aur 6 plus 3 arthaat 9. To ham pahunchenge yahaan 10 kyonki hamen lena hoga maximum of 6 plus 4 aur 6 plus 3 isaka aansar hai 10, to hamaara project samaapt hoga kam se kam 10 dinon mein. Agar hamaare project mein 4 activity hai A, B, C aur D jisamen ki 5, 6, 4 aur 3 saptaah, din, maheene jo bhee unite hai agar itana samay lagata hai aur usakee nirbharata yah hai ki A aur B independent hai, C, A aur B donon par nirbhar hai aur D maatr B par nirbhar hai to us project ko poora karane mein hamen 10 unite ka samay lagega. Yah hai forward pass kee ganana arthaat aisee gaana jisamen ki har activity ko hamane EST arthaat jab vah shuroo ho sakatee hai to hamane usako shuroo kar diya.

(Reference Time 32:55)



To aaiye aage badhate hain aur nyoonatam avadhi ka aakalan karane ka ek aur udaaharan dekhate hain jahaan par ki A, B, C, D, E yah network bhee ham pahale bana chuke hain sirph isamen avadhi aur jod dee gaee hai. To agar usamen A mein 3, B mein 4, C mein 4, D mein 3 aur E mein agar 2 din ya 2 saptaah lagate hain aur unakee nirbharata is prakaar hai, to hamako yah project karane mein kam se kam kitana samay lagega?

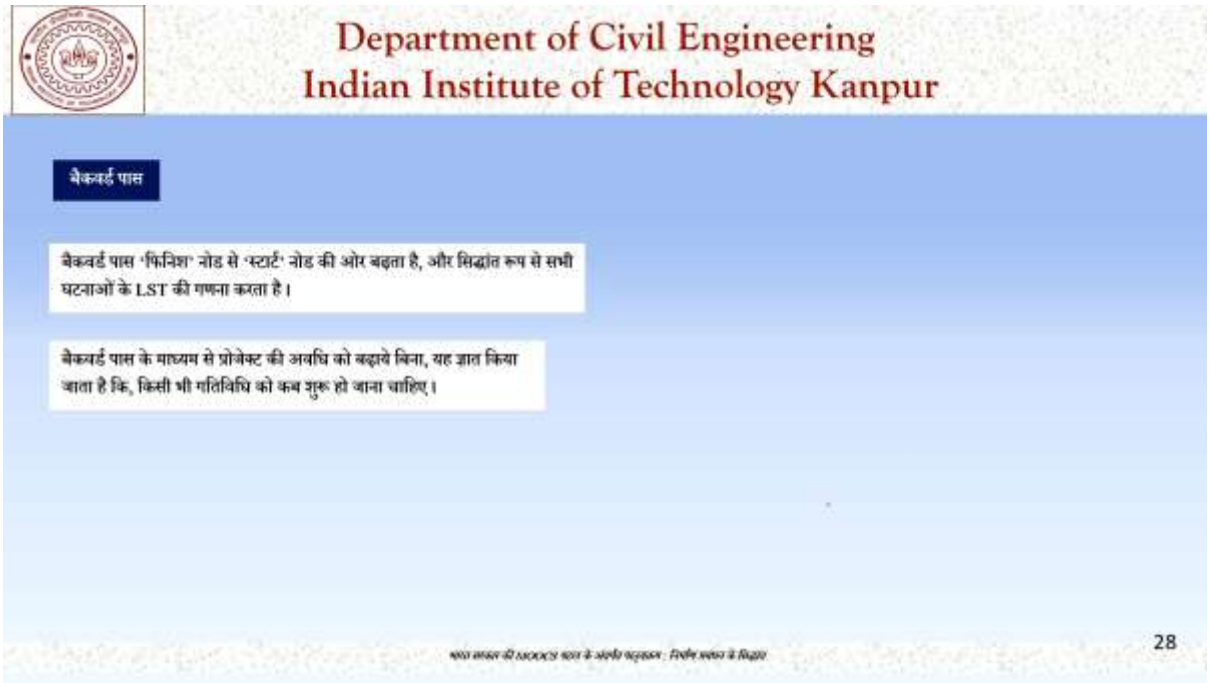
(Reference Time 33:30)



Yah dikhaaya gaya hai is chitr mein. Isakee detail discussion ab ham nahin kar rahe hain pichhalee bar hamane aapako karake dikha diya tha aur ham dekhenge ki yahaan par hamaare pass aaega maximum of 6, 8 aur 6 arthaat 8, yah project poora karane mein hamen 8 din lagenge kyonki yahaan par project samaapt karate samay hamen yah route, yah route aur yah route yah teenon hee activity lekar aanee hai. To inake peechhe ka calculation aap yahaan se chalenge agar starting point se to aap svayan kar sakate hain aur aap dekhenge ki jahaan par diya hua hai ki jahaan jahaan do arrows mil rahe hain vahaan par ham usako maximum lekar

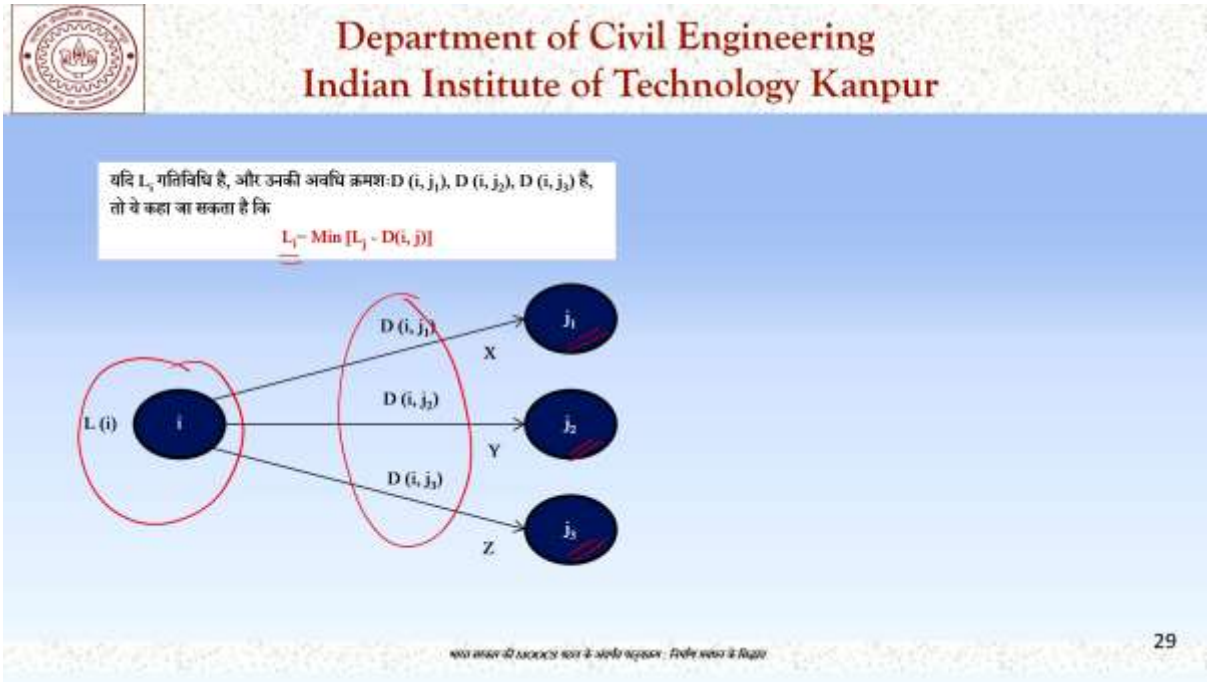
ke calculate kar sakate hain. Jaise ki yahaan par ham yahaan se pahunchana hai aur yahaan se pahunchana hai to yahaan par hamako maximum of 3 aur 4 arthaat 4, to yahaan par pahunchane ka earliest time hai 4. To yah baat dhyaan mein rakhate hue ham is prakaar se project kee nyoonatam avadhi calculate karate hain.

(Reference Time 34:35)



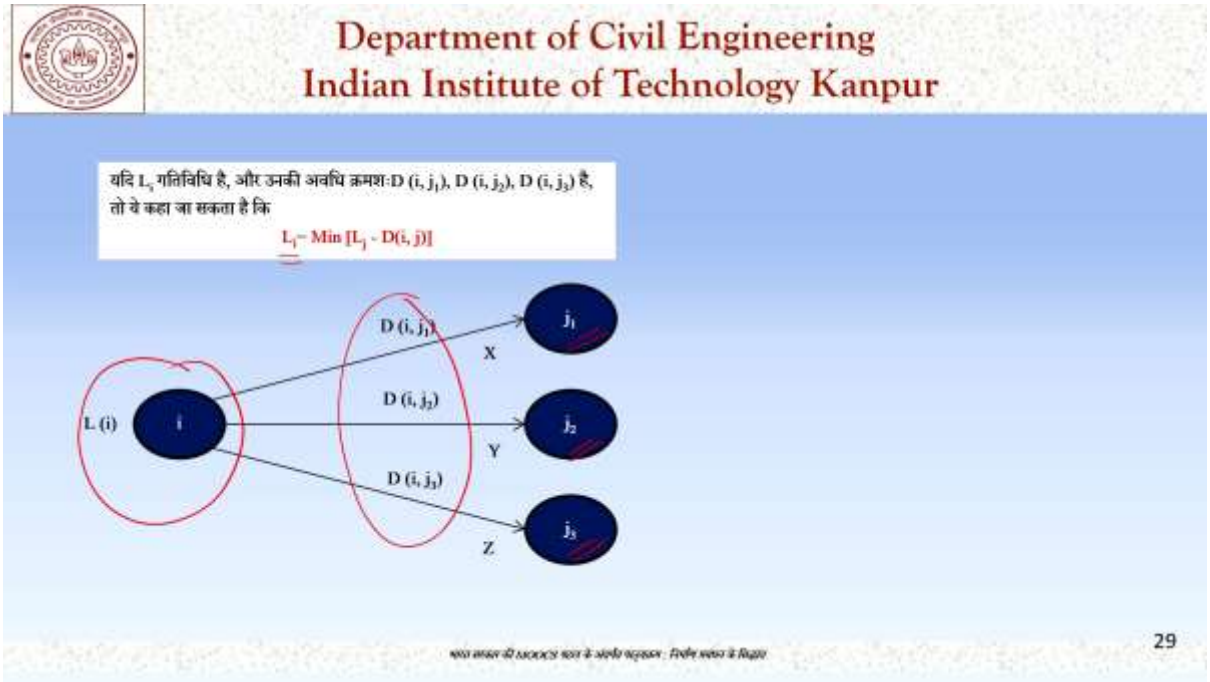
Ab baat aatee hai backward pass kee. Backward pass finish node se staart node kee or badhata hai aur siddhaant roop se sabhee ghatanaon ke LST kee ganana karata hai. Yah kaise hota hai yah ham aapako abhee dikhaenge. Backward pass ke maadhyam se project kee avadhi ko badhaaye bina yah gyaat kiya jaata hai ki kisee bhee gatividhi ko kab anivaary roop se shuroo kar diya jaana chaahie. Isake lie hamen aavashyakata padatee hai backward pass kee.

(Reference Time 35:05)



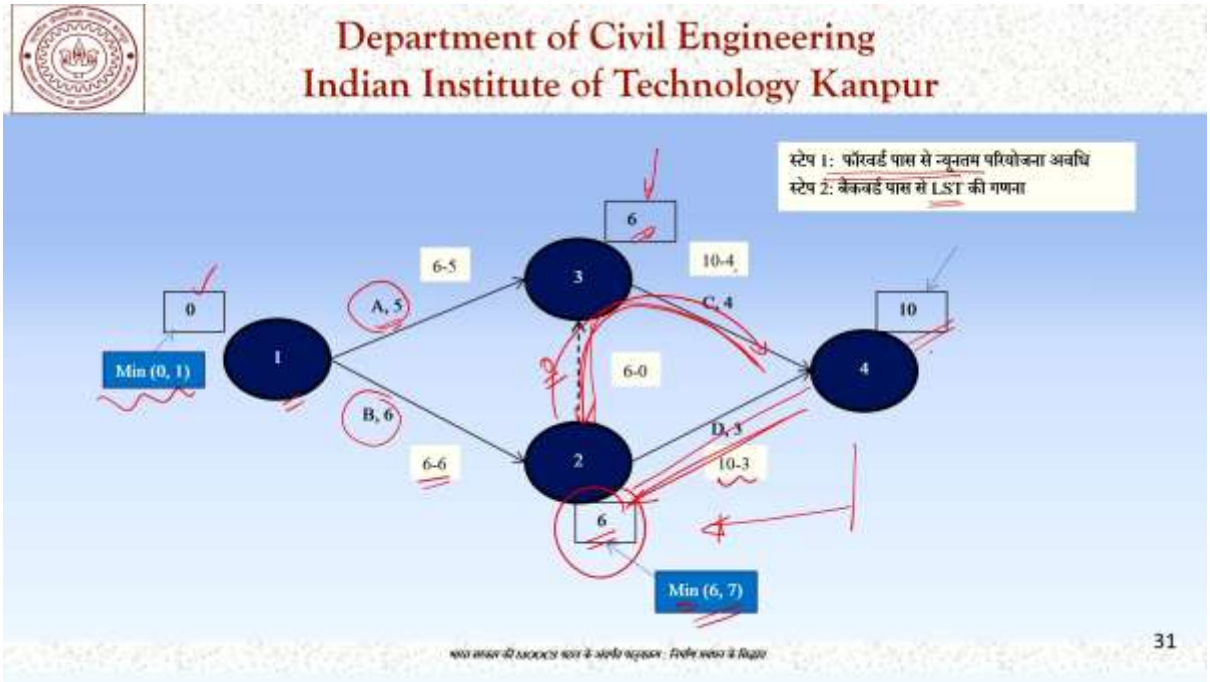
Vahaan par agar 3 activity Z is prakaar se aatee hain to hamako yahaan par pahunchane ke lie yahaan ka jo L(i) hai arthaat latest 9, vo ham nikaalane ke lie L(j) arthaat yahaan ke lie latest time mein se yah durations ham ghata kar ke lekar aae aur dekhen ki yahaan par minimum kya hai. Yah baat aapako svayan kisee example ke through samajh bhee lenee chaahie aur yah main aapako homework ke roop mein chhod raha hoon. Yahaan par sirph formula diya hua hai.

(Reference Time 35:44)



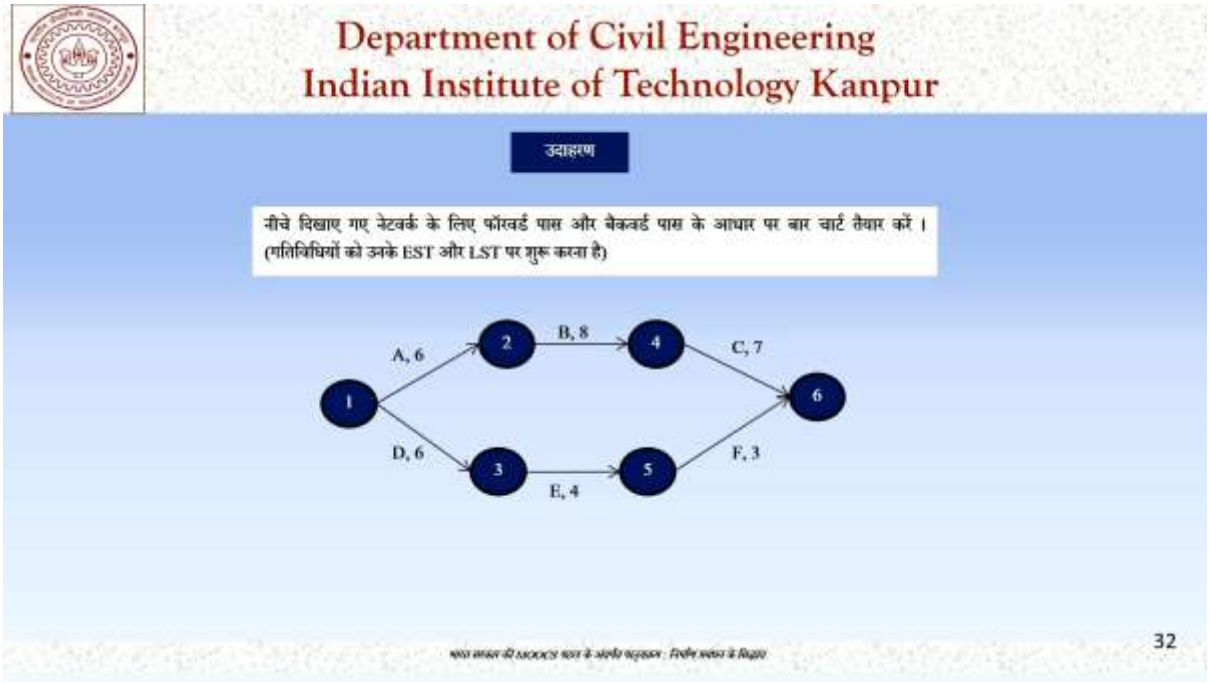
Aaiye ek udaaharan dekhate hain backward pass ka. Vahee gatividhiyaan hai A, B, C aur D hamaara project hai 4 gatividhiyon ka aur deta bhee vahee hai e mein 5 din, B mein 6 din, C mein 4 din aur D mein 3 din.

(Reference Time 36:02)



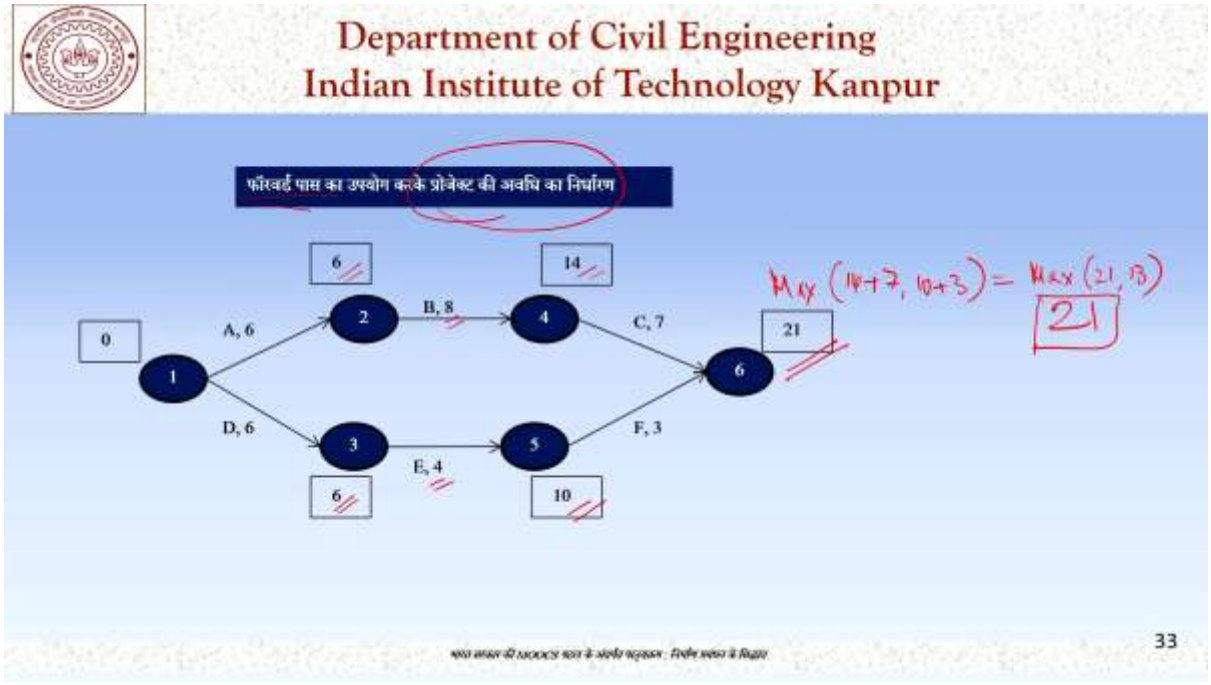
To hamane yah to tay kar liya tha ya yah calculation kar liya tha ki forward pass se nyoonatam avadhi 10 din hai. Ab baat yah aatee hai ki hamen kaun see gatividhi kab anivaary roop se shuroo kar denee chaahie? Isake lie ham shuroo karenge peechhe se arthaat finish se kyonki ab hamen yah pata chal gaya hai ki hamaara project 10 din ka hai to hamen kaun see activity kab anivaary roop se shuroo kar denee chaahie? Is baat kee ganana ham karenge aur har activity ka latest starting time nikaalenge. Jo latest starting time aae hain vah yahaan par die hue hain. Yahaan par agar hamen 10 mein khatm karana hai to yahaan par hamen kab pahunchana chaahie? 10 minus 4 arthaat 6 par. Yahaan par hamen kab pahunchana chaahie? Minimum of 6 aur 7 kyonki 7 hamaara aa raha hai yahaan se aur 6 hamaara aa raha hai. Yahaan se to kyonki hamen yahaan bhee jaana hai aur yahaan bhee jaana hai kyonki hamako jaana to idhar hai lekin ham backward pass kar rahe hain to ham yah route dekhenge aur yah route dekhenge, is route mein 6 hai kyonki yahaan par 0 hai to 6 aur yahaan par hai 7, 10 minus 3 aur usaka minimum hai 6. To latest starting point jo yahaan par hamaara node hai vah aaya 6. 6 minus 6 yahaan par ham pahunch gae 0 aur 6 minus 5 yahaan par aa gaya 1, to minimum of 0 aur 1 is 0. To hamaara project 0 par hee shuroo hoga lekin activity A aur activity B kya hamen ek saath shuroo karane kee aavashyakata hai. Aap is deta ko dekhenge aur sochenge to aap jaanenge ki nahin yah aavashyak nahin hai. Ek bar aap svayan soch kar dekhie phir ham log isakee aage charcha karenge.

(Reference Time 38:09)



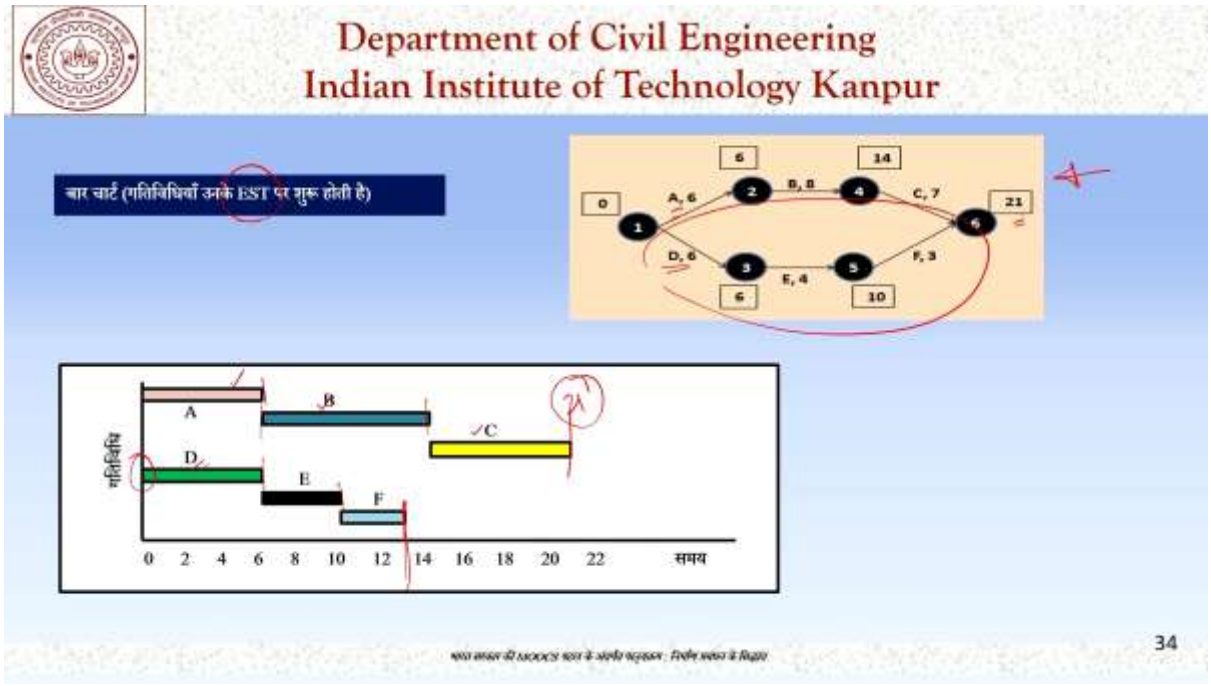
Ek aur udaaharan ham lete hain jahaan par ki network seedha hai activities A, B, C, D, E, F jis prakaar se dee gaee hai vahaan par dee huee hain. Activities A, B, C, D, F unakee nirbharata aur unakee avadhi yahaan par dee huee hai to ab hamako nikaalana hai forward aur backward pass ke aadhaar par bar chart, ki kaun see activity kab shuroo kee ja sakatee hai aur kaun se activity kab anivaary roop se shuroo kar denee chaahie?

(Reference Time 38:43)



To aaiye aage badhate hain ham forward pass ka prayog karate hain aur yah tay karane kee koshish karate hain ki project kee avadhi kya hai? To ham yahaan se shuroo honge, yahaan par 0 plus 6 to ye aa gaya 6, 6 plus 8 ye aa gaya 14, yahaan par 0 plus 6 to aa gae 6, 6 plus 4 is equal to 10 aur yahaan par 14 plus 7 hamaare maximum of 14 plus 7 aur 10 plus 3 arthaat maximum of 21 aur 13 jo ki hai 21. To arthaat ham is project ko 21 dinon mein ya 21 unite mein hee samaapt kar sakate hain. To ab isaka bar chart representation kya hoga?

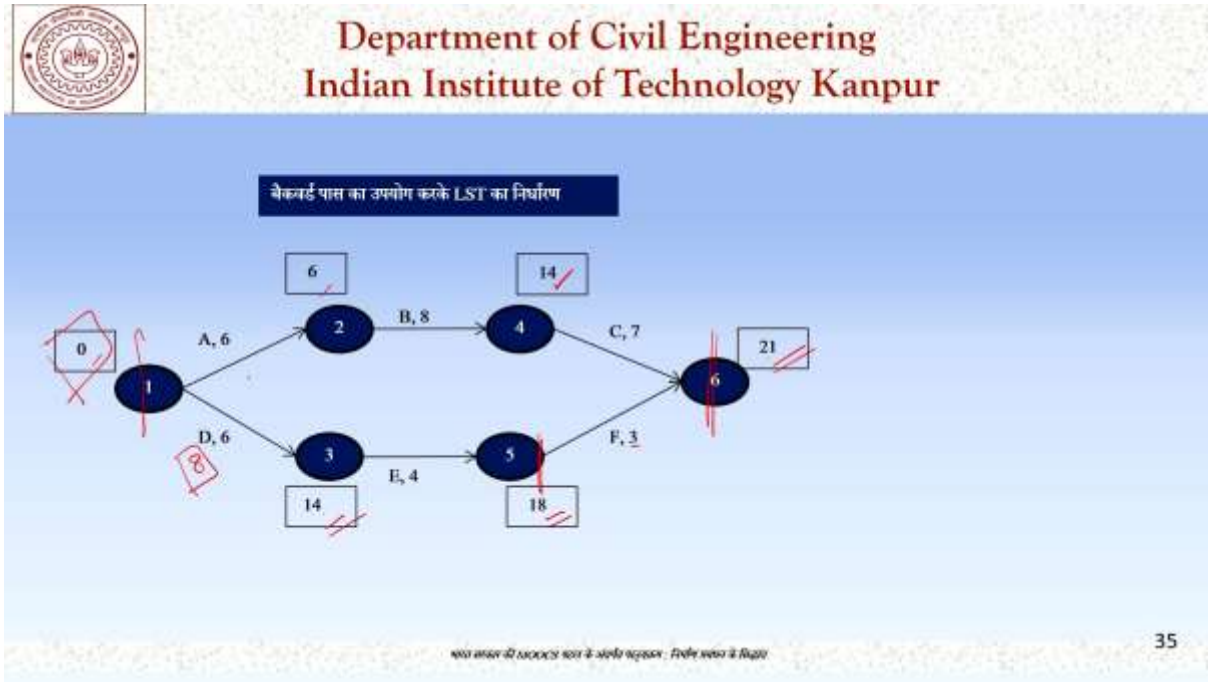
(Reference Time 39:31)



Vo hai yah ki yah to hamaara tha network. Isake aadhaar par hamane dekha ki ham A, B aur C kab kar sakate hain A shuroo kiya 6 par khatm hua, B 6 pe shuroo hua aur 14 par samaapt hua, C 14 par shuroo hua aur 21 par samaapt hua kyonki ham EST se har activity shuroo kar rahe hain to D jo ki independent activity hai A ke saath shuroo ho sakatee hai. To hamane D ko bhee yahaan se shuroo kar diya aur yahaan par bhee aaye 6 aur phir 4, 10 aur 3, 13. To

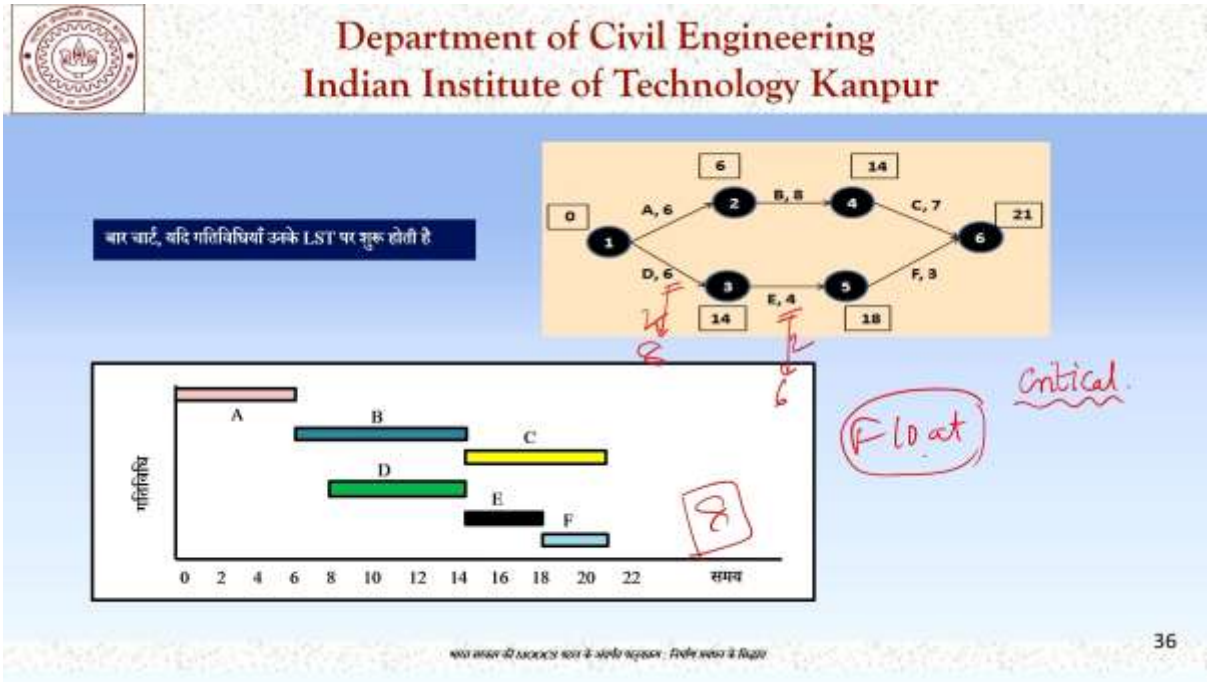
hamaara yah jo loop tha neeche vaala yah loop 13 par samaapt ho gaya aur yah loop 21 din tak chala. Ye hua EST par activity shuroo karane kee bar chart.

(Reference Time 40:26)



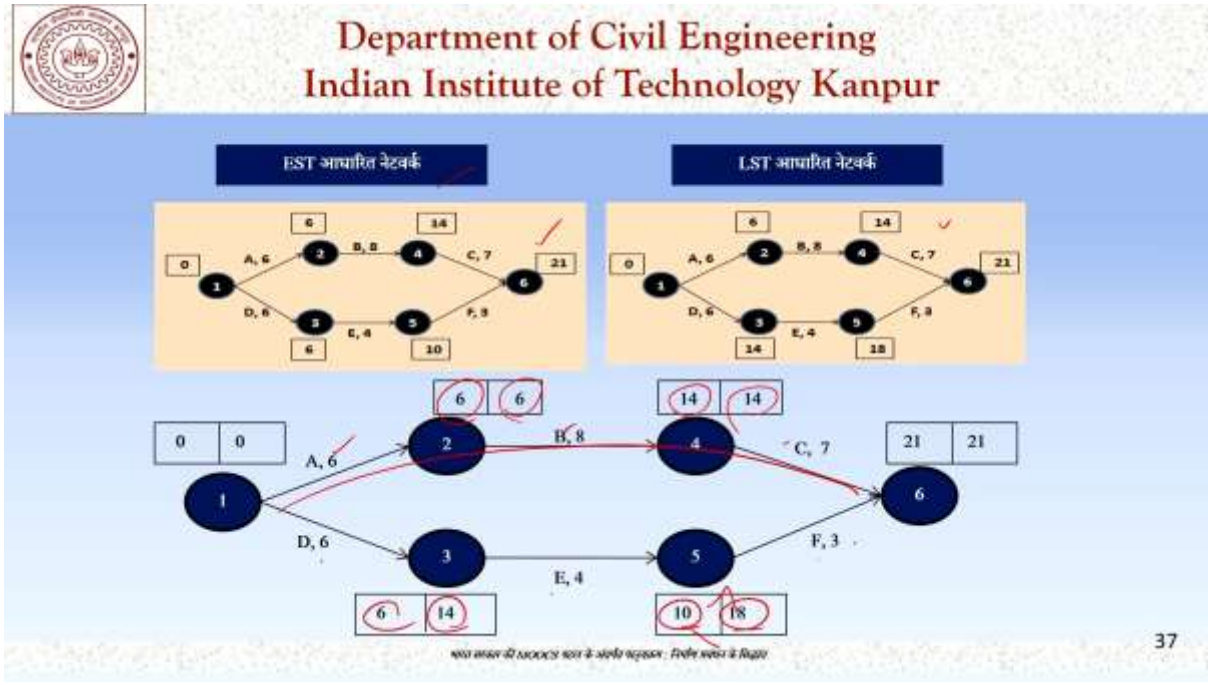
Ab agar ham isee baat ko LST karana chaahe, ham yah jaanana chaah ki kaun see activity kab anivaary roop se shuroo kar denee chaahie? To hamako karana padega backward pass. To ham pahale nirdhaarit kar chuke hain ki hamaara project 21 din chalega. Ab 21 din mein yah project samaapt karana hai to isake lie F kab shuroo kar denee chaahie? 21 minus 3 is equal to 18, E kab shuroo kar dena chaahie? 18 minus 4 is equal to 14 aur D hamen kab shuroo kar dena chaahie? 14 minus 6 is equal to 8. Vo baat doosaree ki ham is loop se aate hain oopar se, C hamen shuroo kar dena chaahie 21 minus 7 is equal to 14 par, B hamen shuroo kar dena chaahie 14 minus 8 is equal to 6 par aur A shuroo kar dena chaahie 6 minus 6 is equal to 0 aur obvious hai ki project to 0 par shuroo hee kar dena chaahie. Ab project shuroo karate samay A aur D donon shuroo kie jaen ya sirph A shuroo kiya jae yah baat yahaan par spasht hokar aaee.

(Reference Time 41:33)



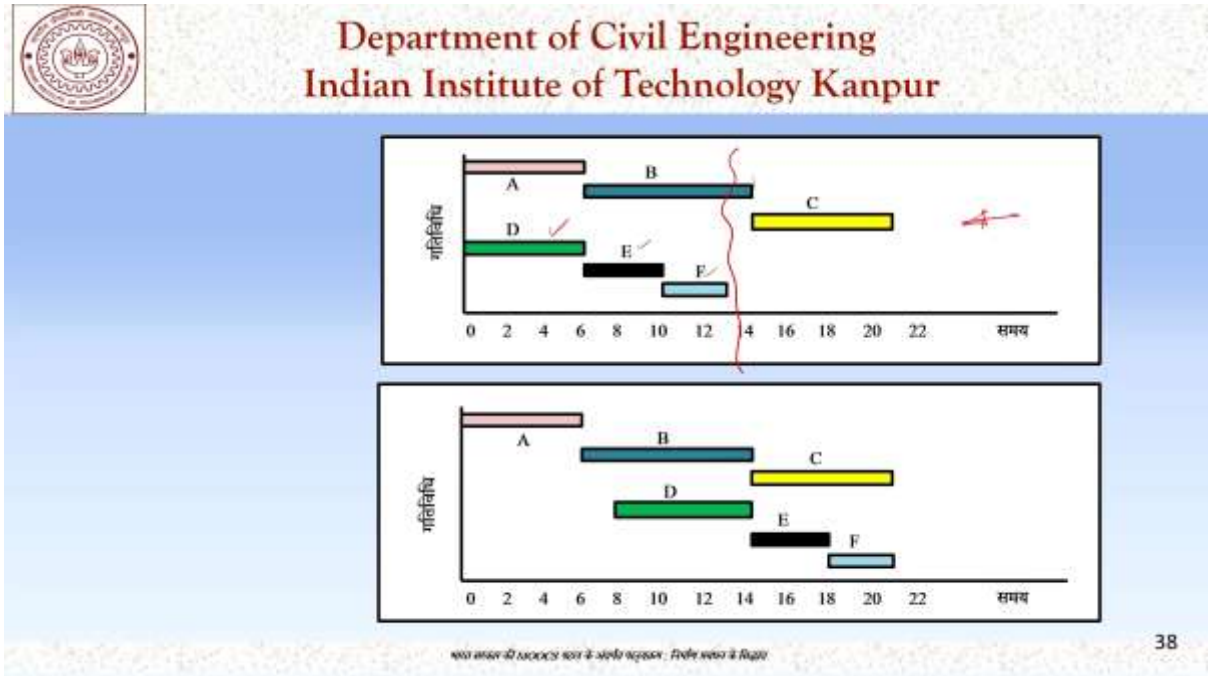
Ab isako agar ham bar chart ke roop mein dekhenge, to sthiti aisee banegee. Kisee bhee project mein ham us path ko ya us raaste ko dhoondhate hain jahaan par ki sabhee activities jo ki critical hain vo hamen mil jae, vah kahalaata hai critical paah. To critical path jaanane ke lie ham forward pass aur backward pass ka prayog karate hain phir har gatividhi ka float nikaalate hain. Jin gatividhiyon mein float 0 hota hai unako ham critical maanate hain vah activities critical hotee hai unaka monitoring vishesh roop se kiya jaana chaahie kyonki unamen dile project par bhaaree pad sakata hai. Ab jaise yahaan ka jo udaaharan hai ham yah dekh sakate hain ki hamaare pass D, E aur F milakar ke 8 din ka float hai. Ho sakata hai ki ham D 6 din kee jagah 8 din mein poora karen, E 4 din kee jagah 6 din mein poora karen tab bhee hamaare pass kuchh float bachega kyonki hamane 2 din yahaan badhaaya 2 din yahaan badhaaya hamaare pass kul 8 din ka float tha. To is prakaar se ham apane sansaadhanon ko aavantit kar sakate hain/ unako readjust kar sakate hain to yah mahatv hai hamaare network ka. Is network ko ham is prakaar se use karate hain project mein critical activities ko Identify karane ke lie ya unako chinhit karane ke lie.

(Reference Time 43:03)



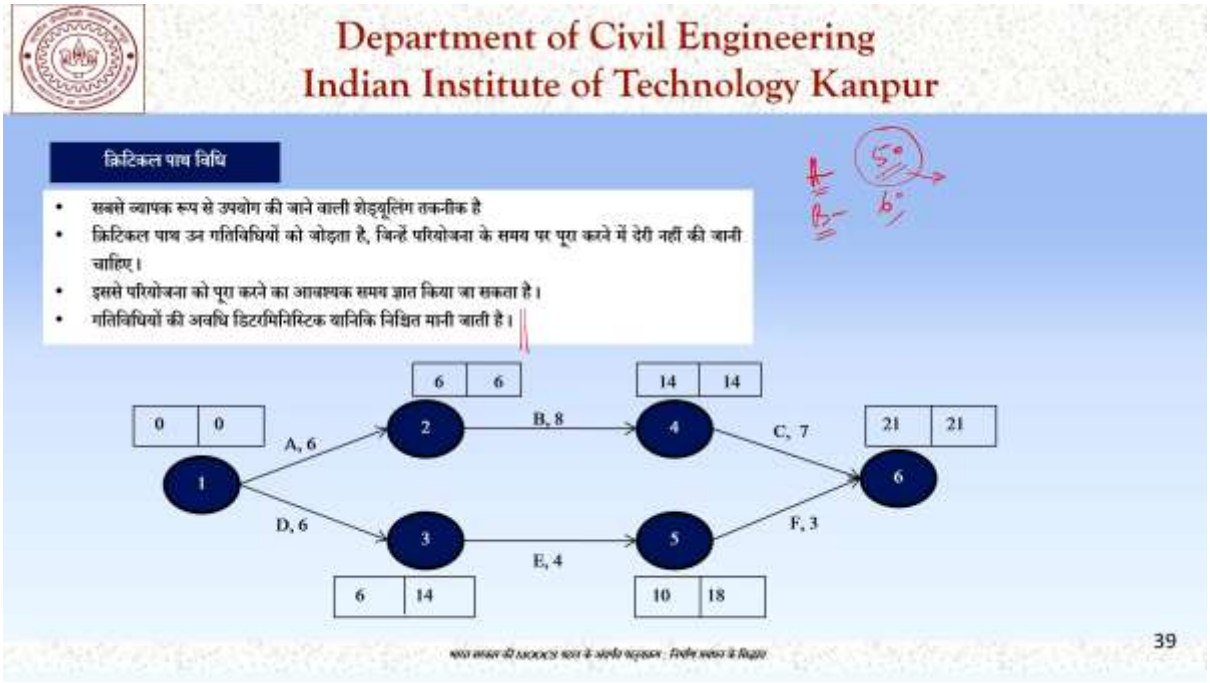
To ab EST par aadhaarit network ka agar ham dekhenge to is tareeke ka samay diya hua hai. LST par aadhaarit network ka samay yahaan par diya hua hai aur usako ham aksar represent karate hain is prakaar ki ham kisee bhee network mein EST aur LST, EST minus LST, EST minus LST, EST LST is prakaar se dikhaate hain. To yah dekhana hota hai ki EST aur LST earliest starting time aur latest starting time jahaan par ek hai arthaat float nahin hai vah activities critical maanee jaatee hai. To is case mein is udaaharan mein yah paath hamaara critical hai A, B aur C hamaare critical path par hain aur D, E aur F non-critical activities hai. Haan yah dhyaan rakhana chaahie ki non-critical to hai lekin kya ham in activities ko kabhee na shuroo karen to kya project khatm ho jaega? Nahin, to ek float hai ek seema hai. Us seema tak ham isamen thoda play kar sakate hain usamen thoda bahut gunjaish rakh sakate hain usase adhik nahin.

(Reference Time 44:13)



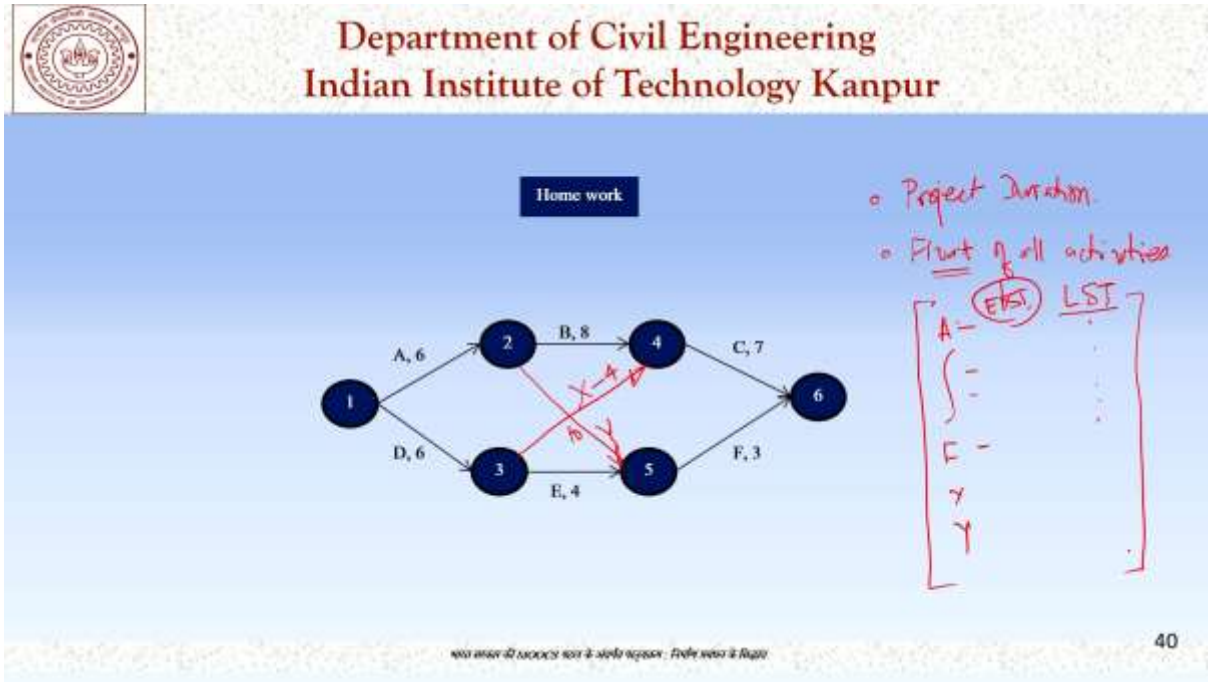
Yah cheej hamane aapako pahale bhee dikhaee thee is prakaar se ham apane bar chart ko dekh sakate hain. Bar chart mein aur network mein ek antar hota hai jo ki aapako samajh mein aa gaya hoga. Vah hai ki bar chart se ham yah dekh sakate hain ki agar ham kisee project mein maan leejie 14 unite par hai to ham monitoring kar sakate hain ki kya ham sahee chal rahe hain. Agar ham is network ko follow karana chaahate hain, to 14 par hamaaree D, E aur F sab khatm ho jaana chaahie. A aur B bhee lagabhag khatm ho jaane chaahie ya yah bhee ho sakata hai ki jo calculation hai vah 14 mein B bhee shaayad khatm ho jaata hai. To bar chart ke aadhaar par ham project kee monitoring kar sakate hain lekin network jab banaate hain to network time ke scale par nahin hota hai to vahaan par monitoring karane mein dikkat hotee hai lekin nirbharata spasht roop se dikhaee detee hai, bar chart mein nirbharata nahin dikhaee detee hai lekin samay bahut spasht roop se dikhaee deta hai.

(Reference Time 45:20)



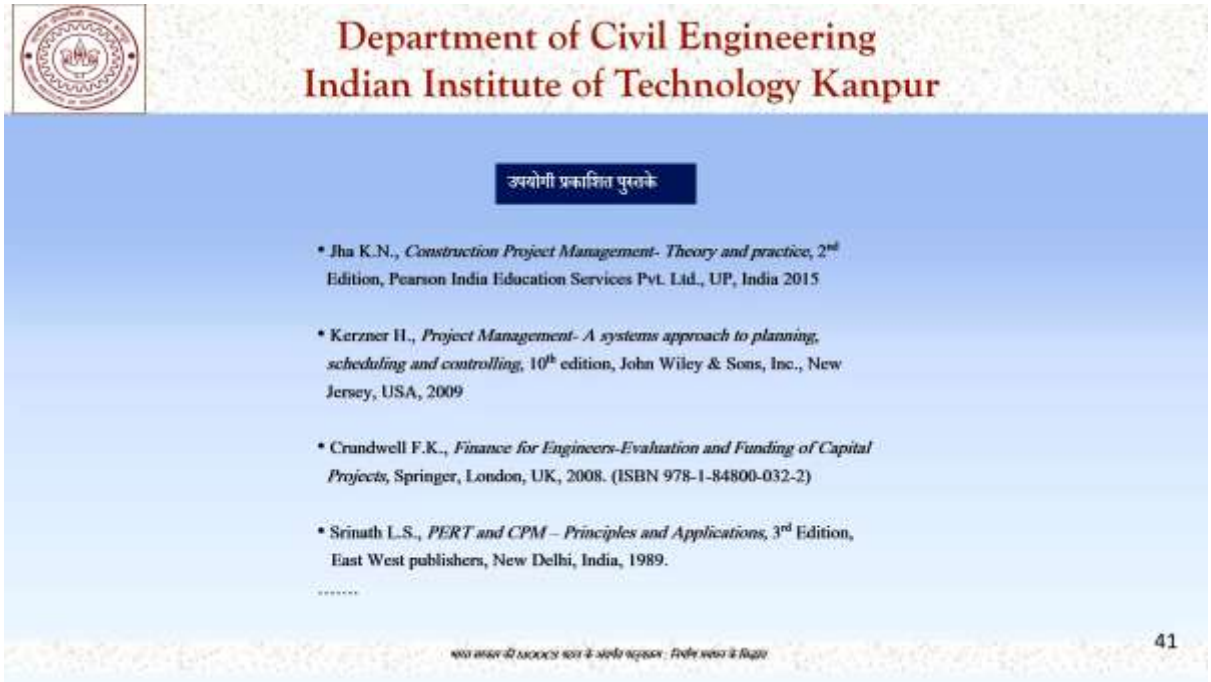
Aaiye aage badhate hain aur critical path vidhi ka ek sankshipt vivaran dekhate hain. Sabase vyaapak roop se upayog mein kee jaane vaalee scheduling takaneek hai yah aur critical path un gatividhiyon ko jodata hai jinhen pariyojana ke samay par poora karane mein deree nahin kee jaanee chaahie. Isase pariyojana ko poora karane ka aavashyak samay bhee gyaat kiya jaata hai aur gatividhiyon kee avadhi deterministic yaanee nishchit maanee gaee hai yah baat bahut hee mahatvapoorn hai. Abhee tak hamane jitane bhee udaaharan die usamen yah kaha ki activity A hai vo 5 din mein samaapt ho jaegee, yah activity B hai vah 6 din mein samaapt ho jaegee. To isakee kya guarantee hai kee activity A 5 din mein ho jaegee ya 6 din mein ho jaegee? Isake lie ham log charcha kar chuke hain ki gatividhi kee avadhi nirdhaarit karane mein usakee maatra kitana kaam involved hai, kis rate se vah kiya jaega, kitana sansaadhan ham usamen laga rahe hain in sab kee bhoomika hotee hai aur usee ke aadhaar par yah nambar nikal kar aata hai. To abhee tak hamane jo network mein calculation kiya hai usamen yah maan liya hai ki ham koee bhee gatividhi ek non avadhi mein pooree kar lenge aur phir pooree analysis kar lee. Ham jab is gatividhi kee avadhi mein anishchitata lekar aaenge ki shaayad 5 din mein ho lekin ho sakata hai kabhee-kabhee 6 din bhee laga sakate hain. To vah anishchitatata ham kaise isamen incorporate karenge usakee charcha ham log shaayad agale kisee lecture mein karenge. Is network par ham log charcha kar chuke hain.

(Reference Time 47:08)



Aur homework ke roop mein main chaahoonga ki isamen agar ham yah gatividhi X aur yah gatividh Y jisamen ki maan leejie 4 aur 10 din lagate hain yah jod diya jae, to aap calculate karie project duration aur yah tay karane kee koshish karie ki har activity ka float kitana hai, of all activities arthaat har activity matalab A se lekar F aur X aur Y in sabhee ka earliest starting time yah gatividhiyaan kab shuroo kee ja sakatee hain aur latest starting time yah gatividhiyaan kab aavashyak roop se shuroo kar dee jaanee chaahie isaka calculation aap karen aur dekhen ki aapako aaj ka jo vishay hai vah kitana samajh mein aaya.

(Reference Time 48:15)



Aur isake saath ham aaj ka lecture samaapt karate hain aur hamesha kee tarah ek soochee aapako dete hain jisamen ki dee huee hai pustaken jo ki is module hee nahin balki is paathyakram mein aap sahaayak siddh hongee. Dhanyavaad.