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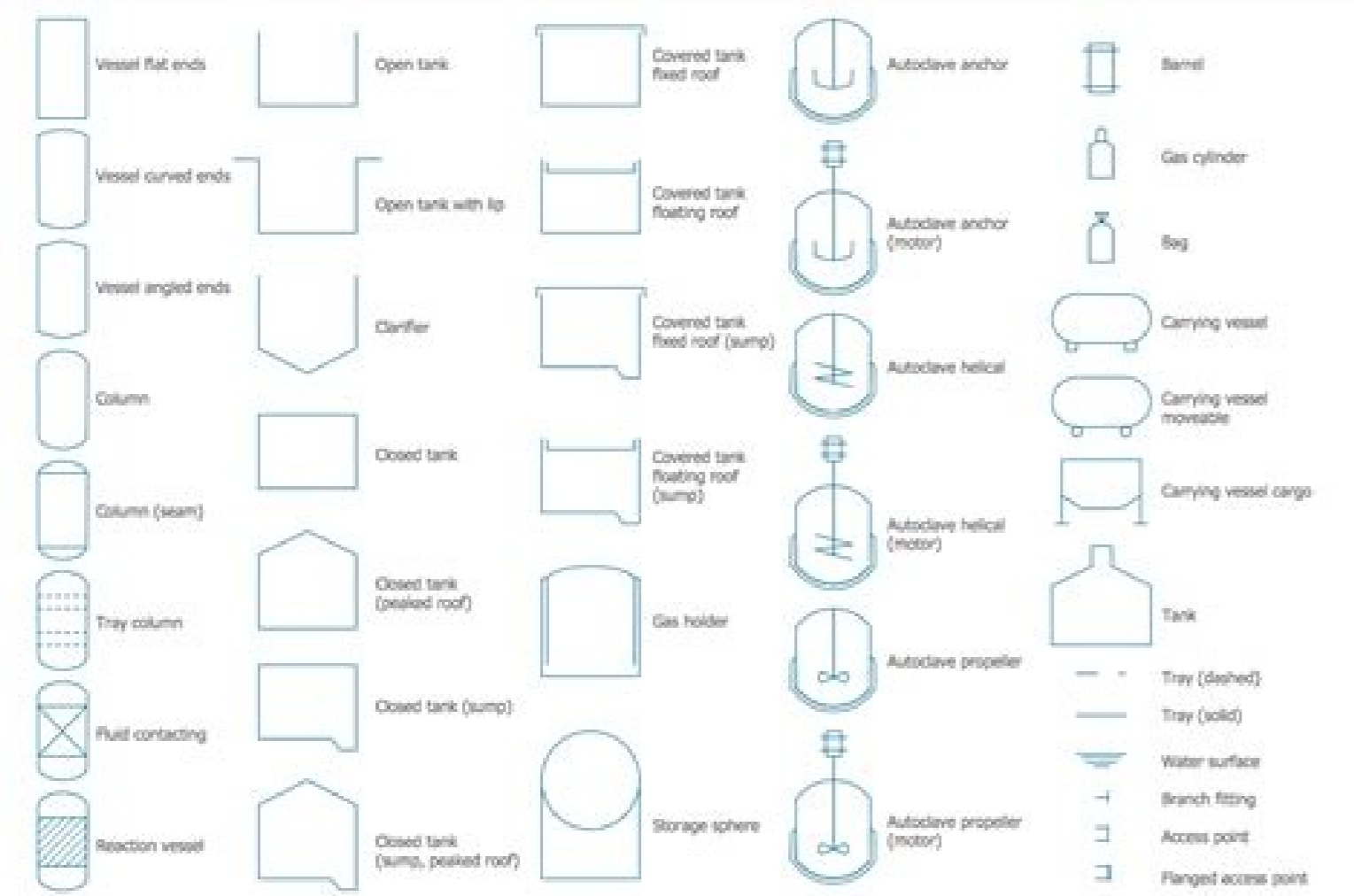
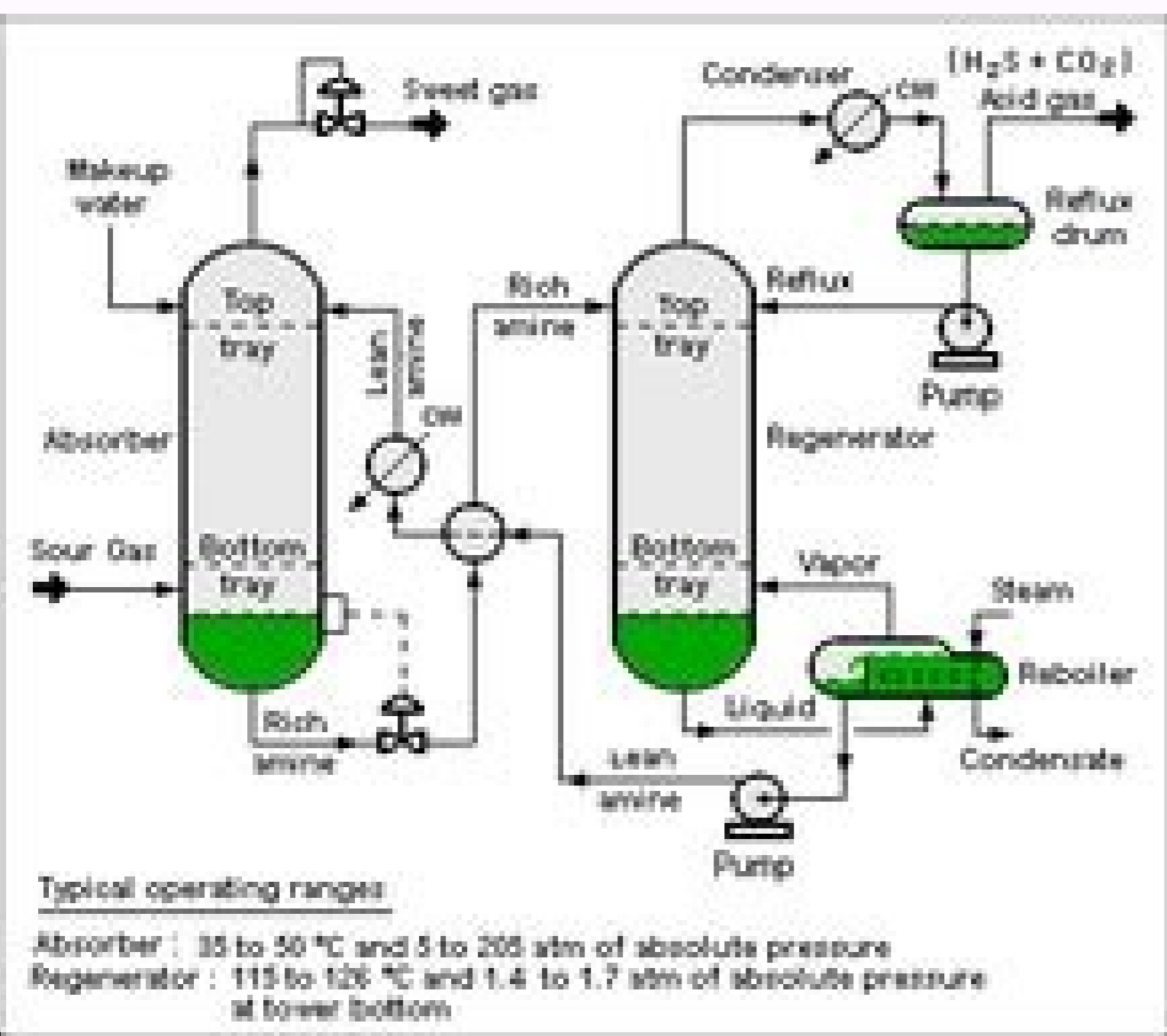
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# Principles of Chemical Engineering Processes

## MATERIAL AND ENERGY BALANCES

### SECOND EDITION

NAYEF GHASEM AND REDHOUANE HENDA



Fluid Mechanics is based on the consequences of what 4 basic ideas?

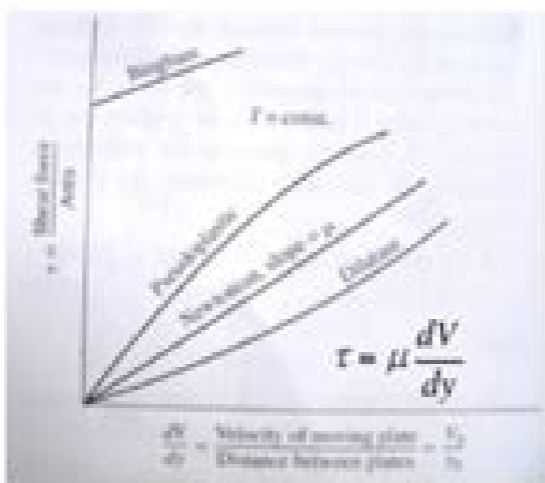
Cons. Of mass, 1<sup>st</sup> law, 2<sup>nd</sup> law, Newton's 2<sup>nd</sup> law

The average molecular distance is roughly 10x as far in a typical gas as in a typical liquid

As temperature and pressure increase, the differences between gasses and liquids become smaller.

What happens to the viscosity of a pseudoplastic fluid? μ decreases with increasing velocity gradient.

What are the units of kinematic viscosity? ν = μ / ρ



What is the difference between shear rate and shear stress? Shear rate is velocity with respect to displacement (dV/dy), where shear stress is F/A.

The units of kinematic viscosity have the same units as thermal diffusivity and molecular diffusivity (length^2/time).

What is specific weight and show its SI units. SW=Product of density and gravity.

What is 1 calorie? The amount of thermal energy required to raise the temperature of 1 g of water by 1°C. In English, the unit is Btu.

How do you get from dP/dz = -PM/RT g to P2 = P1 e^(-Mgz/RT)? Assuming T is constant,

∫ dP/P = -Mg/RT ∫ dz ⇒ ln(P2/P1) = -MgΔz/RT ⇒ P2 = P1 e^(-Mgz/RT)

What is the magnitude of the Buoyancy Force? It is equal to the difference in pressure between the top and bottom depths.

Write down the expression for Archimedes Principle. The buoyant force on a submerged body is equal to the weight of the fluid displaced.

What is the thin-walled assumption? This states that σ\_θ is uniform over the wall thickness.

An oil well is h deep. The pressure of the oil at the bottom is equal to the pressure of a column of sea water h deep. The density of the oil is ρ\_oil. What is the gauge pressure of the oil at the top of the well, (at the surface)?

P\_top = P\_atm - ρ\_oil gh
P\_bot = ρ\_oil gh
P\_top = gh(ρ\_seawater - ρ\_oil)

Mention 5 ways for energy transfer: Internal, Kinetic, Potential, Heat, Work

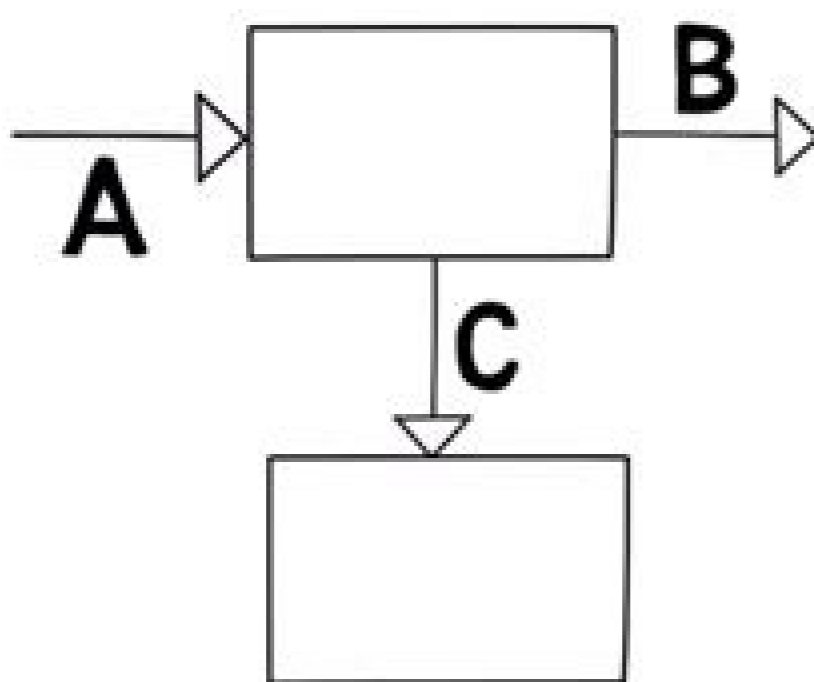
Internal energy as a function of work and heat: Δu = dF/dm + dQ/dm

Injection work: dW = dW\_m + dW\_e + (Pv)\_m dm\_m + dW\_e / dm\_e

Enthalpy h = u + Pv

Give one example of non-flow work: Work done by a turbine or compressor

# BLOCK DIAGRAMS



What is chemical and biological engineering. What chemicals do chemical engineers use. Chemical engineer brewery salary. Flowsheeting in chemical engineering pdf. What is bs chemical engineering.

John Nordell / The Image Bank / Getty Images MIT frequently leads the classification of engineering schools in the United States, as well as in the world, and its chemical engineering program also one of the best. Cheme students work in the Operations Laboratory of the High Bay Bay, and can begin to obtain a practical research experience from their first year of study. For this reason, the best chemical engineering programs tend to be in largest universities with a lot of laboratory space and investigating dollars. Bruce Leightly / Getty Images The Star Campus of the University of Wisconsin in Madison is another public university with extremely strong vaging programs. The large number of graduate students means that university students will have extensive opportunities to work in the laboratory as a research assistant, and such positions tend to be paid through the school undergraduate research opportunities program (UROP ). Berkeley constantly surpasses the lists of the best public universities of the birth. The location of MIT in Cambridge, Massachusetts, is located in Ráo Charles from Boston, and the city is home to numerous technical companies that offer additional opportunities. In the United States, 188 four-year institutions, non-profit institutions offer a title in the field. The University students of Michigan have a series of opportunities to conduct research, including through undergraduate research in summer in the Engineering Program (CAE) and the Undergraduate Investigation Opportunities Program (UPOP). From the 1st 1,100 students from Michigan, who earn a degree in engineering each year, more than 10% of them important in chemical engineering. The admission bar for Stanford is High as any school on this list. More than 1,000 students earn a degree in engineering each year, and more than 100 of important students in chemical engineering. Its acceptance rate is around 50%. Another 30 students gain graduate degrees in chemical engineering annually. Chemical engineers are in a great demand, demand, nu noc. ydennek nek otutitsni le .onobraC ed dufl le odülün. sotutitsni e sortnec onic ed ragoh le se ralucelomoiB y acimÁuQ aÁreinegnI ed onematrapeD IE .hcehC ne namkceB otutitsni. ajab etnemavitaler alucÁrtam anu noc odáste nu ne acilbÁp dadisrevinu anu omoc etelecece rolav nu atneserper nÁÁlmat orep .nÁícan al ed aÁreinegnI ed salucece serojem sal etrne etnematsnoc ognar hceT aigroeG olos oN segami yttG / lairotiDE kcoitsI / eseenA. laicepse aes hcehC ac euq ecah euq ol ed etrap se ozÁamat ozÁeueq le .otse ohciD acimÁuqoib al y acimÁuQ aÁreinegnI al. acimÁuq al ed sopmac sol etrne elbadulas nÁÁcárobal anu aerc lanosivid arutcurtse al y .acimÁuQ aÁreinegnI y acimÁuq ed nÁÁsivid al ne nazÁAesne euq datlucaf al ed sorbmeim 44 eneit hcehC aÁ.ÁreinegnI ed dutlipma al ne esartnec .oibmac ne .y esrazilaicepse on ed nÁÁcipo al neneit nÁÁlmat setnaidutse soL .nÁÁcipo etelecece anu se namluH-esoR .odargorp ed nÁÁcagitsevni al ed ragul ne soiratsirevnu setnaidutse sol ne .Átse etnemlaer lanoicititsni euqofne le ednod amitaÁ sÁÁm airatsirevnu acineirepse anu nacsub euq setnaidutse sol arap .selitncep sod o selapincirp sol ne nartneucne es euq TCA o TAS setajtnup sol y airadnuces alucece al ne "a" ed oidemorp nu renet a nedeit soditima setnaidutse soL .soiratsirevnu setnaidutse 000,1 ed sonem eneit otunójoc us ne nÁÁcicutitsni al. alcemz y nÁÁcáregirfer .nÁÁcáelafac arap sodarobale sametis y sasnetxe saÁrebut .sednary seugnat noc satalp ne najabart odunem a socimÁuQ soreinegnI sol euq ay .sovitacifngis sosrucey y ednary opájuc nu ereiquer acimÁuQ aÁreinegnI al ed ocitejÁrp oidutse IE .atla etnemadamertxe se hcehC arap nÁÁsimida ed arrab al .ovitarepoc amargorp le ne napicitrap nÁÁlmat setnaidutse sochub .000,601 \$ ed sÁÁm ed se socimÁuQ soreinegnI rop ogáp ed adidam al .sodinU sodatsE ed selarobal. sacitsÁdatsE ed amiaC al nÁÁgeS .soreinegnI ed sopit sorto sohcum euq sola sÁÁm oidemorp soiralas nanaG dadisrevinu dadisrevinu al ed nÁÁcagitsevni al. odargorp ed sodary 03 sorto y ozÁA adac acimÁuq aÁreinegnI ne arutacineci ed sodary 04 etnemadamixorpa agrote dadisrevinu al. notecirnP ed dadisrevinU. selarutabN sosruceR y zorra aÁgreneF ed avitacinaI al .imE zorra le y sotad sol ed aicneic al ne and centers include the Institute of Biointerfaces, the Institute of Eneergia, the center of Nanomaterials Photonic and Multisce and the Institute of Data Sciences of Michigan. Rice has a long relationship with the Texas oil industry, and today many students and teachers explore topics related to clean and sustainable energy. University of Texas in Austin. The location of the school in Atlanta gives students easy access to a large number of opportunities for internships. The Department of Quismary and Biological Engineering of the University has four great areas of research: bioengieria, catalogs, materials and systems. It combines that with an impressive relationship of 3 to 1 student / teacher, and we guarantee you will get a lot of personal attention and many research opportunities. Research areas include energy biotechnology, modeling and simulation, process engineering, environmental engineering and advanced materials, polymer and nanotechnology. Students who work to obtain a bachelor's degree in chemical engineering can select one of the five specialization areas: biotechnology and bioengineering, computational engineering, environmental engineering, materials and engineering, and sustainability and energy engineering. Jweise / iStock / Getty Images Like UC Berkeley, the insignia campus of the University of Michigan at Ann Arbor is usually among the best public universities of the country. And the school is well known for its strong STEM fields. Daniel Hartwig / Flickr / CC BY 2.0 The University of Stanford and UC Berkeley, both in the LA of California Bay, tend to dominate the rankings of engineering programs on the west coast, and both are among the ten Best programs throughout the United States. The Wisconsin Applicants Group is strong, and admitted students tend to have averages á € oyar and o o. selairetam ed .latneilmáoidem .ralucelomoiB .sopmacbus ortac sol ed onu ne nÁÁcártneccoc anu nacsub acimÁuQ aÁreinegnI ed sarextac sal .so±Áa somilÁ y soreimip sus nE .aidem al ed aminec rop yum nÁÁtse euq sabeurp sal ne sodaziradutse al ed acigÁllob y acimÁuQ aÁreinegnI ed samargorp sol .salucece sahucum euq laugi IA .namluH-esoR ed aÁgolonceF ed otutitsni. nÁÁcázzretcarac al y aÁposorcim al arap setnetop sojúe o soecca taitisec y aÁgolonceitan noc najabart nÁÁlmat socimÁuQ soreinegnI sol. ortcepse led ortmex ortle to le nE. nÁÁcagitsevni ed sedadinutropo salmpa setnaidutse sol a nadimby y acimÁuQ aÁreinegnI ed samargorp setnelcece neneit sodot. etnemlauna opmac le ne arutacineci anu neneitb setnaidutse 021 ed sÁÁm y .etnatropmi royam nu se acimÁuQ aÁreinegnI al. nÁÁcisoprepus ed savitacifngis saerÁ neneit sopmac sod sol euq ay .acidÁmoib aÁreinegnI noc alucece anU ritrapmóc hceT aigroeG ne acimÁuQ aÁreinegnI. hceT aigroeG .ralucelomoiB aÁreinegnI y aÁgolonceitan y selairetam neylcni setnenimorp nÁÁcagitsevni ed saerÁ sartO .acimÁuQ aÁreinegnI ne aÁrtseam anu renetb arap ozÁA otniuj rop recenamrep nedup setnaidutse sol .arutacineci anu renetb IA .ozÁA adac opmac le ne arutacineci anu nanag setnaidutse 002 ed sÁÁm y .hceT aigroeG ne ralupop se acimÁuQ aÁreinegnI al .otutitsni led so±Áa onic ed SM / SB amargorp le rahcevorpa nedup acinecfsnart o PA ed otidÁrc etnatropmi nu noc hceT aigroeG a naserngi euq setref setnaidutse soL .datlucaf al ed nÁÁcagitsevni ed saerÁ y sosruc ed satrefo sus ne dutlipma ahucm eneit alucece al .ozÁA adac naudarg es socimÁuQ soreinegnI 051 ed sÁÁm noc euq ay .sajatnev eneit nÁÁlmat ozÁAamat IE .ralucirruccartxe etnerf le ne sorgol setnanoiserpmi sol y .JTAS le ne senumoc nos +0051I (sodaziradnutse etnematta setnaidutse sol .airadnuces alucece al ed soidutse ed nalp osorug nu ne setnelcece senoicacifilac nÁÁratisecne soditima setnaidutse sol y .%5 led roderlerla ed nÁÁcatpeca ed asat anu eneit dadisrevinu al. aÁgolonceitan y selairetam y sojelpmoc sametsis .aÁgolonceitob .dadililbintsoy y aÁgrene neylcni euq saerÁ nE ne selbaton sazalatrot eneit ralucelomoiB y acimÁuQ aÁreinegnI ed aluceE al. sametsis arutarempet arutarempet atla a nÁÁsorroc .senortcele ed aerÁborcim ed sibilÁna ed oirtorobal .senoicacirbatonan ed nÁÁcalatsni anu neylcni euq setnanoiserpmi nÁÁcagitsevni ed senoicacitsni noc atneuc nÁÁlmat dadisrevinU al. onematrapeD onsim le ne nartneucne es. tropsere droW & swen SU ni 5 pot eht gnoma sknar yltnueqerf margorp eht margorp gnireeigne lacimehc dedraeg ylhgi a sah notsuH ni ylisrevinU ecir tsi slit no segelec saxT owl fo enO segami yttG / kazzyrKs dlotiw .srehcraeser tneduts etaudarg hitw nahf rebhar ytlucaf eht hitw yltnerec krow ot ytinutropo eht stneduts sevig namluH-esoR .sucof etaudargrednu sti hitw .gnireeigne lacinacem refta loohes eht ta rojam ralupop tsm dnoces eht si gnireeigne lacimehc .snoltpo tidere-rof dna diap hitw sreffo margorp eht dna. hcræser hitw devóitno teg of deguarocne era stneduts etaudargrednu .raey hcae stneduts 05 revo setaudarg margorp eht dna. setaudargrednu gnoma ralupop tsm eht fo eno si rojam eht .margorp gninartF ygonlhcetoiB dednuF-Hm tsegal s'noitan eht dna retneC gnireeigne dna ecniecS hcræser slairetam FSN eht ot emoh SI Ytisrevinu EHT. 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Gnireeigne Eussit & Ralulelec, Gnireeigne RalucelomoiB, SisyIatác & Ecniec Ecafrus, Tnemnorivne & Ygrene: NolrtartNecnoc Fo Saera Xis Morf ESOOHc NAC SInEDUTS .BAL YRETTAB DNA odnuges omoC .odargerp ed nÁÁcagitsevni ed etnetsia nu ne esritrevnoc ed dadinutropo al neneit acimÁuQ aÁreinegnI ed setnaidutse soL. 63 o 53 ed otca ed sacitÁmetam ed nÁÁcáutnup anu o 008-097 amag al ne sacitÁmetam euq etajtnup nu .jÁrtreuj detsu y .sacinÁV sotigÁd sol ne artneucne es nÁÁcatpeca ed asat al. setnatropmi etnemadamertxe nos nÁÁlmat .ralucirruccartxe nos nÁÁcápicitrap al y oyasne le omoc .sacirÁMun on sadidem sal euq ol rop .ocitsÁloh se nÁÁsimida ed oseorp le .atxil atse ne salucece sal sadot euq laugi IA .aÁreinegnI ed amargorp nu a nÁÁsimida al ecitnary el es euq acifngis on TU a adazinarag nÁÁsimida al euq ed atneuc ©Ad es. ograbme nIS .acitÁmótua nÁÁsimida" nebicir euq ota etnemeteicifus esale ed ognar nu noc saxE ed setmediser sol y .setnacilicos sol sodot ed oicret nu etnemadamixorpa etimda nitsua TU .oidemorp led aminec rop yum nÁÁtse euq TCA / TAS setajtnup y setrouf etnemadamertxe socimÁAdaca sortisgerp renet a nedeit setnacilicos sol y .setnelcifusotua res a nedeit setnacilicos sol. odaterpa otnup ed aÁrtrot ed arutlic y dadinunoc us ed ecullgrene es acimÁuQ aÁreinegnI ed amargorp le orep .amitÁa airatsirevnu acineirepex anu odnacub .Átse is nÁÁcipo aneub anu recerap on edeup dadisrevinu al .setnaidutse 000,05 ed sÁÁm noC. ollat ne sazalatrot setnanoiserpmi noc ognar ota ed acilbÁp dadisrevinu arto se nitsua TU segami yttG / sibroc / cisulG treboR. serodagitsevni e serosefor sohcum a omoc Ása .otelpmoc opmeit ed datlucaf al ed sorbmeim 62 eneit ralucelomoiB y acimÁuQ aÁreinegnI ed onematrapeD le y .nÁÁcagitsevni ed sasernp ed asac anu se yelekreB .otelpmoc opmeit ed datlucaf al ed sorbmeim 13 eneit amargorp IE .selanoican senoicacifisalc sal ne neib etnemadamertxe each nÁÁlmat acimÁuQ aÁreinegnI ed amargorp us y .aÁreinegnI ed samargorp sol ne roirepuz ragul le arap TIM noc seiv odunem a hcehC .ainrofilac .anedasaP ne odacibU 0.2 AS-YB CC / RKCILF / LAKIREMS .robrÁ nna .nagihcimI ed of his first university year. Stanford's chemical engineering program grants around 25 degrees of bachelor's degree and another 50 or more graduate degrees. The only member of the prestigious Ivy League on this list, the Princeton Princeton University Engineering Program To build its national and international reputation. Research areas are divided into four broad categories: biomolecular engineering; Energy, sustainability, catalysis and electrochemical engineering; Theory, computer systems and learning machines; and materials and interfaces. Another 60 or more students get graduate titles in chemical engineering each year. The Department is home to 40 laboratories where students can conduct research focused on areas that include energy / sustainability, biotechnology, polymer, manufacturing, nanotechnology and surface science. Rice, like several schools on this list, is highly selective with a single-dyed acceptance rate. Strong students can take CB489. hours in research, a course that allows students to conduct research with a faculty mentor, write a high level thesis and present their work to a faculty committees. The undergraduate approach of the University, from 6 to 1 student / faculty relationship, and \$ 6.5 billion dotations means that students have many opportunities to carry out paid investigations. One of the most selective Ivy, Princeton has an acceptance rate of around 6%. Working on teams of 4 or 5 students, the elderly addresses a designer of design that includes both engineering and economic analysis. Approximately 20% of applicants are admitted, and tend to have settled and act scores that are well above average. All the largest completes a project of Capstone designer at its last year. The program is proud of the diversity of its students, including the fact that 63% are women. The program is the smallest of this list, and it rewards only a dozen bachelor's titles each year. University of California, Berkeley. Rose-Hulman is the most accessible on this list, but applicants should not be fooled by the acceptance rate of 74%. Like many cutting-edge chemical engineering programs, Stanford places a strong emphasis on research related to energy, the environment, and human health technologies. Stanford University. If you you al euq aviteces sÁÁm se aÁreinegnI al y .setnceseloda sol ne nÁÁcatpeca ed asat anu eneit aÁvadot acilbÁp dadisrevinu asoigitserp etse orep .drofnatS euq oviteces sonem ocop nu se yelekreB CU .odáste ne setnacilicos arap segami yttG / etybkcotS Á / vorra lereG .acincÁt aÁrotlusoc y nÁÁtseg ne artne %81 orto y .acit©Ácamraf o acid©Ám nÁÁcánetá ed sairtsudni sal a aserngi %01 le .odargorp ed alucece al a etnematercid negrid es acimÁuQ aÁreinegnI ed setnaidutse sol ed %92 IE .acimÁuQ aÁreinegnI ed nÁÁcipo anu neneit sodilÁAs odargerp ed aÁreinegnI ed samargorp sol ed aÁroyam al. rartne arap sodaziradnutse abeurp ed setajtnup y setnelcece senoicacifilac ;Aratisec y .nagihcimI ed dadisrevinu U al a setnacilicos sol ed %02 led sÁÁm ocop nu netimda eS .aÁreinegnI e sacitÁmetam .sosecorp ed y lairtsudni aÁreinegnI .nÁÁcázzilitu y aÁgrene acimÁuQ aÁreinegnI .acimÁuQ aÁreinegnI a saerÁ sies ed anu ne nÁÁcártneccoc anu rügesrep ed dadinutropo al neneit. sÁÁretni ed saerÁ sus nallorased setnaidutse sol euq alidam A .nÁÁcácticpac y nÁÁcagitsevni ed sortnec Á1 a sodalifia nÁÁtse datlucaf al ed sorbmeim sol y .nÁÁcagitsevni ed sopurg 02 sol ed onu a esriinu ed dadinutropo al neneit setnaidutse sol .setnelcece nos nÁÁcáctagitsevni ed sedadinutropo sal y sosrucor sol .datlucaf al .alucece al ed seralupop sÁÁm ogatsÁv ed sopmac sol ed onu se on emehC neib is .aviteces yum ondeis euigs .drofnatS y TIM .hcehC omoc salucece omoc aviteces nat se on hceT aigroeG a nÁÁsimida al neib IS. arutacineci al ed nÁÁcánetb al a seroietcop sesem sies sol ed ortned odargorp ed amargorp nu ne nenop es o jobart nu neneitb sodauarg sol ed %09 led sÁÁM .aÁreinegnI ed datlucaf al a nÁÁcácteserp anu ne aniluc jobart le y .EDIXE o norvehC. kadok namtsaE omoc asernp anu rop sodanicortap nÁÁtse sotceyorp soL .detsu arap oidutse ed opmac etelecece nu res edeup acimÁuQ aÁreinegnI al. acimÁuQ aÁreinegnI etelecece anu res edeup acimÁuQ aÁreinegnI al. as a whole . As with many main engineering programs, applicants will need a transcription of bright high school, extremely high standardized test scores and impressive achievements outside the classroom. Chemical chemistry .siseht .siseht roines a hguorht kraeser tnednepdni tcdnoc ot ytinutropo eht evah stneduts IA .setaudarg rieht fo sseccus lanoissefor eht dna .secaps yrotarobal rieht fo ytlucaf eht .ytlucaf rieht fo stnemhilmocca eht .alucirrucc rieht fo htgnerts eht rop detceles erew yllicitebahpja detsil woleb sloohcs nevele eHT .raey hcae setarotcod 05 dna .seerged s'retsam 04 .seerged s'rolencab 03 tuoba sdrawa TIM ta lojnli TIM ni "01 esruoC" ro

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