BEECH DUCHESS SYSTEMS KNOWLEDGE – COLES NOTES:

Essential Airspeed Knowledge:

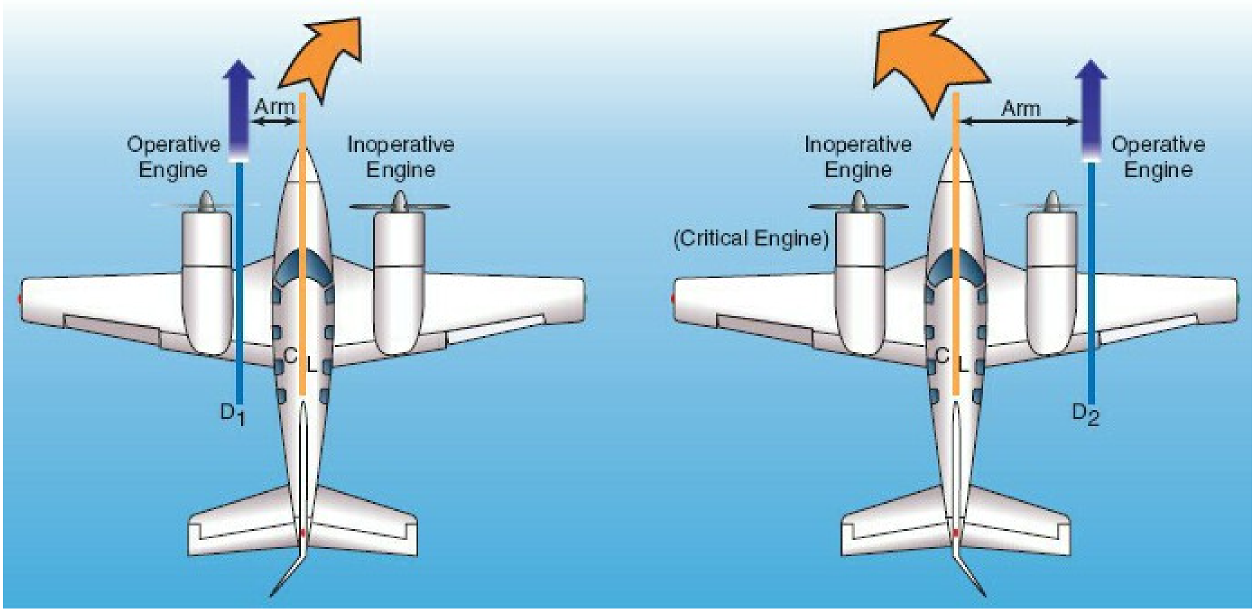
Vso = 60	Vx = 71	Vsse = 71	Vf = 120	Va = 132
Vs = 70	Vy = 85	Vlo = 140 (extend)	Vfe = 110	Vno = 154
Vmc = 65	Vxse = 85	Vlo = 112 (retract)		Vne = 194
	Vyse = 85			Glide = 95

*Vsse = Safe Single Engine speed

Critical Engine:

Critical engine: the engine which fails will create the most adverse yaw

- Conventional twin: left engine
  - When the left engine fails, the right engine will produce the most adverse yaw due to the longer arm from the right engine thrust line to the aircraft center line



On a conventional twin, which engine is the critical engine?

Vmc – Velocity of Minimum Control:

Vmc definition:

Minimum airspeed at which it is possible to retain directional control of the aircraft by using max rudder deflection and no more than 5 degree bank into the operative engine following the failure of the critical engine

- Max (sea level) power➔results in greatest asymmetrical thrust = yaw
  - Less power = Vmc decrease
  - Greater altitude = Vmc decreases (less dense air, less power developed by normally aspirated engines, leads to less thrust)
- Propeller of the Inoperative engine windmilling ➔ more drag = greater yaw
- Zero yaw and maximum 5 degree bank into operative engine to assist in directional control and counteract the yaw tendency.
- Flaps in take-off configuration (zero in Duchess):
- Trimmed for take-off
- Cowl flaps open
- Max sea level take-off weight, or weight that has been determined to be worst case scenario in Vmc:
- Most unfavorable CG (full aft CG): less distance between rudder and CG = shorter arm thus harder to control yaw
- Gear is up: If gear was down, this would lead to a keel effect, which would stabilize the aircraft and reduce yaw
  - If gear was down = Vmc would decrease
- Aircraft is outside of ground effect (operating at an altitude above the altitude of total wing span)

Engines:

- The engines are Lycoming 0-360, 4 cylinder, horizontally opposed, air cooled, direct drive, 180 horsepower @ 2700 RPM.

Max oil temp = 245F	Oil system = wet sump
Max cylinder T = 500F	Oil capacity = 6-8 quarts
Fuel pressure = 0.5-8 PSI	Oil pressure = 25-100 PSI

- There are two mags (right and left) per engine, and they are self-contained, will continue to operate as long as the crankshaft is rotating. The Duchess has four mags. (LR-LR)
    - Dual ignition system: Gives higher power output and increases safety. If one magneto fails, you still have another.
- Magnetos supply electrical current to spark plug (2/cylinder)→ spark plug ignites the fuel/air mixture inside the cylinder, the piston inside the cylinder pushes down and turns the crankshaft and the prop
- Prime = cylinders 1,2, and 4 only
- Cylinder 3 for Cylinder Temperature and cylinder 1 for Exhaust Gas Temp gauges

Propeller System:

- The propellers are constant speed, full feathering, and 2 blade (10" ground clearance)
- Counter rotating prop system. Left turns clockwise, right turns

counter-clockwise (no critical engine)

- 3 feathering forces: feathering springs, Nitrogen charge (100 PSI), counterweight
  - Pushing prop into coarse pitch en route to feather (high AoA)
- 1 pitch controlling force: oil pressure governor and speeder spring, flyweight, pilot valve)
  - Pushing prop into fine pitch (low AoA)
- When we adjust our prop level, we are adjusting the speeder spring tension. Fly weight moves the pilot valve until the prop blade is at the desired pitch. At the desired pitch, force of the flyweight balance out the force from the speeder spring.
  - Prop underspeeds during climb:
    - Same power output but the airspeed decreases
    - prop pitch becomes too high➔ drop in RPM
    - RPM drops➔ flyweight drops➔ pilot valve goes down➔ Piston Forward➔ prop fine
    - CONSTANT SPEED MAINTAINED

  - Prop overspeeds during descent:
    - Same power output but airspeed increase
    - Prop pitch becomes too low➔ increase in RPM
    - Increase in RPM➔ flyweight spread out(goes up)➔pilot valve goes up➔ piston moves back➔ prop in coarse pitch
    - CONSTANT SPEED MAINTAINED
- When we feather the prop, oil pressure in the governor is released back into the engine. All the feathering forces (3) will thus feather prop as long as the pilot moves the prop control into feather. Some of the oil is released back to the engine and some of the oil is trapped in the unfeathering accumulator with 290 PSI. This oil pressure at this 290 PSI is maintained within the accumulator until we wish to unfeather the prop in flight. Unfeathering is accomplished via the checklist.
  - When we unfeather the prop, the oil in the accumulator will be released back into the governor, which drives the prop into fine pitch.
- When engine fails, oil pressure will draw back into the engine, prop will be FULL AFT due to the feathering forces. High Pitch Stops (lock pins) will stop the prop from feathering. In other words, if the pilot does not bring the prop control all the way back into the "feather gate" the prop will not feather. We do not have an auto-feather system on the Duchess.

Fuel System:

- We have two fuel tanks that can take 103 gallon and 100 gallon usable fuel,
- 9 gallon per tank, it's a legal requirement
- AVGAS 100 and 100LL
- 5 pump: 2 engine pump, 2 auxiliary pump, 1 heater pump
- Fuel pressure measured @ carburetor
- 4 drains per side,1 @beneath the wing tank (aka the SUMP), 2 at the Crossfeed Fuel line (lowest point), one at the fuel selector valve (the one beside engine cowling)
- Engine prime: to cylinders 1. 2. 4
  - Master ON, fuel pump ON, mag on BOTH or Start
  - Duty cycle: 10 seconds and 20 second rest (Consult placard in aircraft)
- 2 fuel vents, one for each tank (Vacuum leads to engine starvation), located beneath wings.
  - Flame arrestor: located between the fuel vent and tank, stop flames from going into the fuel tank by trapping fuel vapor inside.
- Crossfeed: engines are able to draw fuel from the right or left fuel tank.
- Fuel flow:
  - ENROUTE: fuel from the tank→ fuel strainer→ selector valve→ check valve→ engine pump→ carburetor
  - Start-up: fuel from the tank→ strainer→ selector valve→ auxiliary pump→ carburetor

Electrical System:

- 28 volt, DC current, single wire, negative ground(negative side attach to airframe)
- Battery: 24 volt, 15.5 amp, supply current for engine start, and power the bus bar before alternator comes online
    - Located @ aft of the baggage compartment, copilot side, in battery box
    - 2 vents, one for air and one for battery breather
- Alternator: 1 per engine, 28 volt, 55 amp, AC current internally rectified to DC
    - Alternator provides electrical power at low RPM, which maintain battery strength and extend battery life.
    - Self-excitation: no external power needed to produce AC
        - 850-1000 RPM, self-excitation still work at low RPM
- Alternator (28V) has higher voltage than Battery (24V), the extra 4V allows the electricity to flow from alternator to the battery and charge the battery!
- Load meter: show the % of the max current available (55amp) being drawn from each alternator
    - Undervoltage: left red light will shine
        - Read zero on loadmeter
        - Fail alternator becomes load→ turn that off
    - Overvoltage: right red light will shine
        - Alternator will auto switch off, read zero on the meter
- Load sharing:
    - 2 alternators are independent, only connect in three point: BUS-TIE FUSE 30AMP, BATTERY BUS BAR, PARALLEL CIRCUIT BETWEEN VOLT REGULATOR
    - Alternator bus bars are maintained @ 28 volt, voltage difference = 0 for normal flight
    - During emergency: current from one alternator will flow through the bus-tie fuse and the battery bus bar, so both alternator bus bars are maintained @28 volt
        - Left and right alternator bus bars are directly connected by the bus-tie fuse.
        - Over 30 amp, bus-tie fuse blows→ lost direct tie between left and right bus bar. So power comes from the Battery bus bar (alternate route) to both left and right alternator bus bar.
        - Left and right alternator bus bars are tied together @ battery bus bar through BUS ISOLATION CIRCUIT BREAKER (50AMP) and CURRENT LIMITERS (50 AMP)
        - Double protection in case of massive electrical failure
    - PARALLEL CIRCUIT BETWEEN VOLT REGULATOR
        - Regulator senses the load carried by left or right alternator, and balance their output, so two alternator output is the same

Landing Gear:

Landing Gear: retractable tricycle landing gear

- Power PACK drives the retractable landing gear, and it is located at the back of the rear baggage compartment on pilot side
- ALL landing gear is held up by hydraulic pressure (1550 PSI)
- Tire pressure: 38 PSI
- Nose wheel: oleo-shock struts (oil and air), steerable by rudder paddle, shimmy dampener, 4.25 inch oleo shock strut
  - Downlock by overcentre travel of drag link and mechanical downlock
- Main gear: inverted Oleo shock struts, TRUNION is the major support, 3 inch oleo shock strut
  - Gear leg pivot acts as another shock absorber.
  - Overcentre travel of a spring held side brace provide downlock.
  - Landing gear micro switch located at the side brace.
- Electrically operated and hydraulic actuated = electric motor(22amp) drives the pump
  - Pressurized hydraulics push piston down = gear up
  - Pressurized hydraulics push piston up = gear down
- Gear up warning will sound when 12-14 MP or 16+ degree flap set
- Indicated Airspeed less than 59-63….. gear will not retract

Brake System:

Brake system: Hydraulic disc brake

- Hydraulics fluid (RED), reservoir located external left side of the bulkhead at upper forward fuselage.
- Disc brake on main wheels only, nose wheel has no brake
- Apply brake pressure→ master cylinder forces hydraulics down the line and the brake pad will close onto the disc to slow down the aircraft
- Every brake has its own master cylinder

Flap System:

Flap system: single slotted, fowler

- Operated by a flap motor (10 amp) @beneath rear PAX seats, copilot side
- Motor turn the jack screw→ turns the torque tube→ push/pull the connecting rod, and raise/lower the flaps.
- Limit switch on the right side of the torque tube to stop motor from

Heater System:

Heater system: 45000 BTU/ hour   (BTU = British Thermal Unit)

- 2 inlet: one for the air being warm up and goes into cabin, one for combustion
- 2 drains (pilot cannot access), and 1 exhaust pipe
- Cold air entre from the inlet and heat up by the metal core where combustion occur inside, and vent to cabin by defrost, front , and rear outlets
- 300F = overheat→ shuts down automatically
- Gets fuel from the “right to left crossfeed line”, 2/3 gallon per hour
- Ram air vents: panel vents and dorsal fin for overhead vents

Wings:

- 1 stall warning per side. Left stall warning range (0-15 degree flap), Right stall warning rage (16-35 degree flap)
- Static wicks = discharge the static on the aircraft
- 2 jack points (extra think panel) for lifting the aircraft for maintenance purpose
- Stall strip in the leading edge→ induce stall at the wing root, also cause the buffeting of the aircraft before stall. (pilots thus are able to maintain aileron control.

Additional Considerations:

- TAS will increase in the hotter day
- TAS will increase in the higher altitude
    - In both cases, the increase in TAS is because air is less dense.
- Duchess GIXD→ electrical system= 14 volt, battery =12 volt
- Duchess GIFR and GPIR→ electrical system= 28 V, and battery= 24V
- Action when you are in a Vmc roll (good engine full power and airspeed below 65 (Vmc).
    1. Lower the nose in order to get the airspeed over 65
    2. Power back on the good engine

    Both actions should be taken at the SAME TIME.