**Automotive Department**

**Summer Project 2021-22**

**Level 2 to 3**

**Name:…………………………………..**



**Torque Converter Task**

There are a series of questions on the back pages of this work sheet. The answers to the questions can be found in the text below.

This exercise will develop your understanding of the operating principles and components found within the torque converter.

The torque converter offers two main benefits. The first is hinted at by the name: torque converters actually multiply torque at low engine speeds, usually by a ratio of about two to one. That means that a car producing approximately 300 ft/lbs. of torque at the flywheel will put out approximately 600 ft/lbs. of torque at the rear wheels (less any parasitic losses from mechanical drag and the operation of the converter itself). The second is that a torque converter allows the car to stop and idle without disconnecting the engine from the rest of the drive train. Basically, a true automatic transmission would not be possible without the torque converter.

The torque converter consists of three main components: the impeller, the turbine, and the stator. The impeller is bolted directly to the flexplate, and rotates at engine speeds (the impeller is an integral part of the outer cover itself). The turbine is splined to the input shaft of the transmission (it is the shaft that protrudes from the back of the converter). The stator is sandwiched between these two, and is equipped with a one way clutch. All three components have canted blades that are somewhat similar to those of a fan. The converter assembly is filled with transmission fluid, which it shares with the rest of the transmission (as a matter of fact, the majority of the fluid in a transmission is contained in the converter). As you read on, refer back to the following illustration to keep track of the different parts:



As the engine spins the impeller, the blades on the impeller pick up the fluid, and force it towards the outer circumference of the converter. The high pressure fluid is then picked up by the blades of the turbine (which are canted in the opposite direction), forcing it (and the rest of the drive train) to turn in the same direction as the engine. If the resistance in the drive train is greater than the force of the fluid, the turbine stays still, and the converter "slips", allowing the vehicle to remain stopped.

At lower speeds (when the drive train(turbine) is spinning slower than the impeller(engine)), the fluid leaves the turbine at an angle, and enters into the stator. The blades of the stator accelerate the fluid, and then send it back into the impeller at a higher pressure, where it is then accelerated again, and sent back to the turbine at an even higher pressure. This is called vortex flow(the arrows in the illustration), and it is what creates the torque multiplication that gives automatic equipped vehicles such strong low speed torque. One way roller clutches in the stator prevent it from spinning backwards (and ruining the vortex effect).

As the turbine picks up speed to match that of the impeller, centrifugal force sends the fluid outward and prevents it from being returned to the impeller. At the point where the turbine is spinning at roughly 90% of the impeller speed, the fluid begins to hit the backs of the stator blades, unlocking the roller clutches and forcing the stator to turn in the same direction as the impeller and turbine. This is known as the coupling phase, and during this time, there is no torque multiplication. This is a brilliant design. Using this system, the torque converter automatically applies the correct amount of torque to the rear wheels. When the vehicle is launching (i.e. under load), the engine(impeller) is spinning, but the drive train(turbine) isn't. The difference in speeds creates the vortex flow through the stator, and applies full torque multiplication (2:1). While this multiplication phase makes tremendous power, it also generates tremendous heat and drastically reduces efficiency: if the converter were to stay in this phase continually (as it would if your stall speed was too high) the transmission's life would be greatly shortened, and efficiency would suffer. To adjust for this, as the vehicle picks up speed and the drive train (turbine) speed catches up to that of the engine (impeller), the converter gradually reduces vortex flow, until the entire assembly is turning at nearly the same speed in the coupling phase. This increases efficiency and reduces heat.

One traditional problem with automatic transmissions is that the converter never achieved a true coupling; that is, there was always a small difference in speed between the impeller and turbine. This was due to the fact that the converter uses fluid for power transfer, rather than a direct mechanical coupling. Thus, the high speed efficiency of automatics suffered, because some of the engine's power was always lost as heat from slippage in the converter. This problem was alleviated somewhat by the development of the lockup torque converter.This type of converter uses a clutch (similar to the type used in stick shift transmissions) to create the needed direct mechanical coupling, which eliminates slippage at highway speeds. The clutch is usually engaged at steady cruising speeds by an electrical solenoid in the transmission. Some drag racers use a switch to manually engage the clutch during runs, shaving some time off of the 1/4 mile.

The basic design of the torque converter is so good that it has barely changed in over 40 years. Most of the modifications that have been made centre around the design of the components themselves, in terms of blade angle, etc. Also, certain converters use a second stator to achieve higher vortex acceleration rates, improving responsiveness.

Question 1.

What is the approximate maximum torque multiplication ratio of the converter?

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Question 2.

What is the impeller connected to?

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Question 3.

At what speed does the impeller rotate?

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Question 4.

What is the turbine connected to?

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Question 5.

Where is the majority of fluid in an automatic gearbox?

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Question 6.

In what direction does the turbine spin, in relation to the engine?

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Question 7.

What happens if the resistance in the drivetrain is greater than the force of the fluid?

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Question 8.

What is the purpose of the stator?

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Question 9.

What is the name of the fluid flow in a converter?

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Question 10.

What is the purpose of the one-way roller clutch fitted in the stator?

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Question 11.

What is meant by the term coupling point/phase?

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Question 12.

What is a major issue during the multiplication phase?

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Question 13.

What was one traditional problem with early torque converters?

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Question 14.

How was this issue resolved?

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Question 15.

State one method of engaging the component you have named above.

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Question 16.

How have torque converters changed over the years?

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Additional questions

a. What is the term called when the converter is producing maximum torque? When the vehicle is pulling away.

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b. What is torque multiplication?

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c. What is meant by the term ‘creep’ in an automatic vehicle?

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d. When the impellor and turbine speeds begin to synchronise, what happens to torque multiplication?

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e. What would occur if the stator did not have a one-way clutch and did not free wheel at coupling point?

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Stall testing is used on automatic transmissions to diagnose:

* the operation of the automatic transmission clutch
* the operation of the converter clutch
* check engine performance

State below how you would carry out a stall test

Initial checks, prior to conducting test:

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How to carry out the stall test:

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