

WINTER – 15 EXAMINATION

Subject Code : 17614

Model Answers

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.

2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.

3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.

4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any

equivalent figure drawn.

5) Credits may be given step wise for numerical problems. In some cases, the assumed constant

values may vary and there may be some difference in the candidate's answers and model answer.

6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.

7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q1 a i) (One mark for each)

- 1. Based on ignition
 - Spark ignition
 - compression ignition
- 2. Based on fuel used:
- a) **Petrol engine vehicles :** Automobiles powered by petrol engine. e.g: scooters, cars, motorcycles.
- b) **Diesel engine vehicles :** Automobiles powered by diesel engine. e.g: Trucks, Buses, Tractors.
- c) **Gas vehicles :** Vehicles that use gas turbine as power source. e.g: Turbine powered cars.
- d) **Electric vehicles :** Automobiles that use electricity as a power source. e.g: Electric cars, electric buses.
- e) **Steam Engine vehicles :** Automobiles powered by steam engine. e.g: Steamboat, steam locomotive, steam wagon.

3. Based on Load Capacity:

- Light duty vehicle: Small motor vehicles. eg: Car, jeep, Scooter, motor cycle
- Heavy duty vehicle: large and bulky motor vehicles. e.g: Bus, Truck, Tractor

4. Based on Suspension system used:

- a) **Convectional** Leaf Spring
- b) **Independent** Coil spring, Torsion bar, Pneumatic.



Model Answers

Q1 aii) (04 marks)

Steering System Functions :

It helps in swinging the wheels to the left or right.

It provides directional stability.

It helps in turning the vehicle at the will of the driver.

It helps in controlling wear and tear of tyres.

It helps in achieving the self-rightening effects.

It converts the rotary movement of the steering wheel into an angular turn of the front wheels.

It multiplies the driver effort by leverage to make it easy to turn the wheel.

It absorbs the road shocks thereby prevent them to get transmitted to the hands of the driver.

Q 1 a iii) (02 marks for each)

Wishbone type suspension system : It consists of two wishbone arm pivoted to the frame. The upperm wishbone arm is shorter in length than lower arm.

The weight of the vehicle is transmitted from the body and the cross member to the coil spring through which it goes to the lower wishbone member.

A shock absorber is placed inside the coil spring and is attached to the cross member and lower wishbone member.



Model Answers



Wishbone type suspension system

Trailing type suspension : A coil spring is attached to the trailing link which itself is attached to the shaft carrying the wheel hub. When the vehicle comes across the bump, wheel moves up and down and it will wind and unwind the spring. A torsion bar is also been used in certain design in place of coil spring . This system maintain the camber and keep the wheel track constant.



Trailing type suspension :



Model Answers

Q1a iv) Principles of jigs and fixture design :Following are the principles of jigs and fixtures design : (Any eight, half mark for each)

- 1) Reduce Idle time
- 2) Minimize cheap accumulation
- 3) Fool proofing
- 4) Clearance
- 5) Rigidity
- 6) Trunnions
- 7) Burr groves
- 8) Easy removal of part
- 9) Inserts
- 10) Design for safety
- 11) Sighting surfaces
- 12) Simplicity in design
- 13) Economical

Q.1. b) i) Synchromesh gear box 😕 03 marks for sketch and 03 for significance)



In synchromesh two synchromesh devices are used while in constant mesh two dog clutches are used

In synchromesh no need of double de clutching while in constant mesh operation of double declutching is necessary.

In synchromesh unskilled drivers can operate while in constant mesh skilled driving or unskilled driving is required



Model Answers

Q.1. b) ii)(03 marks for each)

1) Tempering

Tempering is usually done after quenching, it involves re-heating of the steel in order to reduce the hardness of the quenched steel and improve the ductility, toughness and strength of the spring. Tempering is usually done hand in hand with quenching and is usually a tradeoff between hardness and toughness/strength of steel. This research is aimed at evaluating the effect of normalizing, hardening and tempering on the impact toughness, hard-ness and tensile strength of springs.

2) HARDENING:-

In water quenching the springs were heated to about 850°C to ensure conversion to austenite had been achieved. The springs were then taken out of the furnace and placed in a bath of water to ensure that rapid cooling of the spring occurred.

Q.2. a)Purpose of Automotive aerodynamics shape : (04 marks)

Automotive aerodynamics is the study of the aerodynamics of road vehicles. Its main goals are reducing drag and wind noise, minimizing noise emission, and preventing undesired lift forces and other causes of aerodynamic instability at high speeds. Air is also considered a fluid in this case. For some classes of racing vehicles, it may also be important to produce downforce to improve traction and thus cornering abilities.

In short, Aerodynamic shape of vehicle bodies results in

- considerable reduction of fuel consumption
- improvement of comfort characteristics and
- more favourable driving characteristics of ground vehicles.

Q.2. b) (Any four 01 mark for each)



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nr. No.	Coil spring clutch	Diaphragm spring clutch
Alex	Helical compression coil spring is used.	Diaphragm conical spring is used.
9.	Release leavers requires.	No release levers.
0.	Non-uniform pressure on pressure plate.	Uniform pressure on pressure plate.
Area	Driver requires more effort for disengagement of clutch.	Driver requires less effort for disengagement of clutch.
ð,	During dis-engagement, spring pressure increase.	During dis-engagement spring pressure constant.
0.	Require more space.	Compact in size require less space.
1.	Balancing is complicated.	Balancing is simple.

Q.2. c) (Any four 02 mark for each) Effect of caster and camber on the performance of automobiles :

Caster: The positive castor on the car wheels provides directional stability i.e. straight line tracking is improved. This can be understood by considering similar effect provided on the furniture roller and on the front wheel of bicycle.





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Camber : The positive camber aids steering wheel return after completing the turn i.e it increases straight ahead stability



Q.2. d) Independent suspension system : 02 mark for each sketch and explanation



The independent suspension allows the two wheels to move up and down independently of one another. The wheels can move up and down and yet not lift the frame.

Q.2. e) Manufacturing process of connecting rod : (02 marks for each process)

1. Conventional forging Process:



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The process used in manufacturing the connecting rod and caps are forging as we have discussed before in the process of manufacturing the crankshaft. Starting with a heated rod blank an initial form is given to the rod. After two to three more dies the final shape of the rod is completed. However the flashing must be trimmed by yet another die which shears off the rough edge and produces two holes in either end of the rod. One large hole for connection to the crank shaft and a second smaller hole for connection to the piston pin. The process of this forging process are shown in Figure



The final operations are done using machining procedures. First the large and small holes are milled by a tool in a similar fashion to drilling but more precise. Then the two raised edges surrounding the holes are milled flat and are perpendicular to the length of the hole. Most likely a milling and drilling operation are happening at the same time for the connecting rod bolts which are used to hold the next operation pieces together. In order for assembly the larger of the two holes is cut in half. The cut is made perpendicular to the length of the rod and must have a good surface finish so as not having to need any more machining. Finally the small and large holes are ground leaving a very smooth surface finish.



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2. Powder Forging Process

Powder forging consists of the rapid densification of a heated powder-based preform using a single forging strike. The result is a fully dense net- or near-net shape part suitable for high performance applications where high durability and strength are a requirement. Tight control of the powder perform mass allows the use of a trap die and eliminates any material waste such as the "flash" usually associated with the conventional forging process. Energy savings is another advantage of the process when the forging step directly follows the sintering step, eliminating reheating. Powder forging is done at a lower forging temperature than conventional forging.

Q.2. f) Forging process for Crankshaft

The forging process is a process of processing work piece having a relatively small surface area-to-volume ratio. It is a process by which plastic deformation of the work piece is carried out by compressive forces. Forging is one of the oldest metalworking operations known. This process can be carrying out at room temperature or at an elevated temperature. Called the hot forging or the cold forging. This process is being chosen to produce the crankshaft is because it gives high precision and also harden the material either by hot work or cold work.

The production of the crankshaft involves several different stages so to get the desired shape. These steps are describe in the following diagram:





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Q3. (figure & construction =2 marks, working =2 marks)

A) Construction and working of differential



Construction :-

- It consist of crown wheel attached with bevel pinion which drive the system.
- Bevel pinion attached with cage .
- Two or four planetary gears are mounted spider or cross pin attached with cage.
- Two sun gears are mesh with planetary gears with half shafts.
- Sun and planetary system covered with housing.

Working:-

- when vehicle is going straightthe cage and inner gears rotates as single unit and and two half shaft revolves at the same speed.
- When vehicle is taking turn ,assume the cage is stationary ,then turning one sun gear will cause the other to rotate in opposite direction



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- This rotation superimposed on normal wheel speed when vehicle is taking turn
- Consider N is the normal speed of wheel when vehicle is running straight .
- Inner wheel rotate at N-n and outer wheel rotate at N+n rpm ,where n is super imposed speed of inner and outer half shaft.

Hydraulic brake system	Pneumatic brake system
1.it is used in light vehicles like car, jeep etc	it is used in heavy vehicles like trucks, bus etc
2.Brake works on liquid fluid i.e. brake oil	2. This works on compressed air
3. These brake system stop working as	3.Depends upon reservoir pressure.
engine stops.	
4.Less reliable	4.More reliable
5.Lleakages may collapse system	5. System sustain for a period
6.Required drive pump	6.Required compressor

B) Difference between Hydraulic brake system and Pneumatic brke system

(relevant four points may be considered each point =1 mark)

c)Telescopic Shock Absorber:-

(neat sketch=2 marks, working=2 marks)

Working :-

Figure shows the typical arrangement of telescopic shock absorber rod 'G' is attached with two way valve 'A' and similar two way valve 'B' is attached to the space between cylinder C & D. H is a gland in the head J .When car come across a pump. The eye E would move up and there by fluid will pass from the lower side of valve assembly A to its upper side. But since the valve of the space above A is less by the

volume of rod G the fluid will also exert its pressure on valve assembly B and go to the underside of valve B. This passing of the fluid through valve opening provides the damping.



Model Answers



d) Sheet metal cutting and joining process for car body manufacturing.

(cutting processes =2marks,joining process=2 marks,)

(each point require short explanation)

Following processes are recommended for sheet metal cutting.

- a) Shearing
- b) Bending
- c) Forming
- d) Stamping.

Following processes are used in sheet metal joining

- a) Welding
 - i)TIG welding
 - ii)MIG welding
 - iii)CO2 welding
- b) Riveting
- c) stunning etc.



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e) Design procedure for a simple fixture used in milling:-

(relevant points to be considered each point =1mark)

Following parameters are considered while designing a fixture for milling

- a) Shape of component
- b) Capacity of machine and T slot distance
- c) Locating elements& rest surface.
- d) Loading and unloading of jobs
- e) Clamping arrangement
- f) Indexing device
- g) Tool setting arrangement (Grinding wheel& cutter setting)
- h) Fool proofing arrangement
- i) Ejecting device
- i) Swarf removal arrangement
- k) Rigidity and vibration

Q4.A)

Different Types of chassis(4 marks) i)

Following are the different types of chassis

a)Conventional control chassis:-Engine is mounted in front of driver cabin.

b)Semi forward control chassis:-Engine is mounted half in driver cabin and half in front .outside of driver cabin.

c)Full forward control chassis:-Engine is mounted completely inside the driver cabin.

ii)Explain with sketch working of overdrive:-

(sketch =2 marks, working =2 marks)



Model Answers



Working Principle of Overdrive:-

An overdrive has a faster output speed than input speed. It's a speed increase -- the opposite of a reduction. In this transmission, engaging the overdrive accomplishes two things at once. In order to improve efficiency, some cars have a mechanism that locks up the torque converter so that the output of the engine goes straight to the transmission.

In this transmission, when overdrive is engaged, a shaft that is attached to the housing of the torque converter (which is bolted to the flywheel of the engine) is connected by clutch to the planet carrier. The small sun gear freewheels, and the larger sun gear is held by the overdrive band. Nothing is connected to the turbine; the only input comes from the converter housing. Let's go back to our chart again, this time with the planet carrier for input, the sun gear fixed and the ring gear for output.

Ratio =
$$1 / (1 + S/R) = 1 / (1 + 36/72) = 0.67:1$$

So the output spins once for every two-thirds of a rotation of the engine. If the engine is turning at 2000 rotations per minute (RPM), the output speed is 3000 RPM. This allows cars to drive at freeway speed while the engine speed stays nice and slow.



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iii)Explain construction and working of McPherson Strut type suspension system:-

(figure=2 marks, construction & working =2marks)

A MacPherson strut uses a wishbone, or a substantial compression link stabilized by a secondary link, which provides a bottom mounting point for the hub carrier or axle of the wheel. This lower arm system provides both lateral and longitudinal location of the wheel. The upper part of the hub carrier is rigidly fixed to the bottom of the outer part of the strut proper; this slides up and down the inner part of it, which extends upwards directly to a mounting in the body shell of the vehicle. The line from the strut's top mount to the bottom ball joint on the control arm gives the steering axis inclination . The strut's axis may be angled inwards from the steering axis at the bottom, to clear the tyre; this makes the bottom follow an arc when steering.



iv)Design consideration of jig and fixture design

(Relevant points to be considered min 8 points =4 marks) Important considerations while designing jigs and fixtures:-

Designing of jigs and fixtures depends upon so many factors. These factors are analysed to get design inputs for jigs and fixtures. The list of such factors is mentioned below : (a) Study of work piece and finished component size and geometry

(b) Type and capacity of the machine, its extent of automation.

- (c) Provision of locating devices in the machine.
- (d) Available clamping arrangements in the machine.
- (e) Available indexing devices, their accuracy.



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- (f) Evaluation of variability in the performance results of the machine.
- (g) Rigidity and of the machine tool under consideration.
- (h) Study of ejecting devices, safety devices, etc.
- (i) Required level of the accuracy in the work and quality to be produced.

Q4.B)Attempt any one of the following

i) Explain with sketch working principle of power steering:-(Sketch=2marks,working=2marks)



Working principle:-

A typical power steering system utilizes the same mechanism as the normal steering, with the addition of a hydraulic system that generates the 'power' needed to assist in the steering effort. The following describes how a basic power rack and pinion steering system works.

For providing hydraulic power assistance, a slight modification is made to the typical rack and pinion system described in the previous section.



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As can be seen from the diagram above, part of the rack is modified to form a hydraulic piston and cylinder arrangement. The cylinder is fed on two sides by openings to which fluid lines are attached. The piston is connected to the rack, and moves between these two openings.

When pressurized fluid is fed to any one of the openings, the piston gets pushed and moves in the opposite direction, dragging the rack along with it. At the same time, the other opening vents out the fluid (if present) on the other side of the piston. This is how power is provided, which significantly minimizes the effort needed to steer the vehicle.

The fluid is stored in a reservoir (not shown), and is pressurized with the help of a rotary vane pump, driven by the car's engine through a belt and pulley arrangement. It pulls the low pressure fluid from the reservoir, and pressurizes it before supplying it to the cylinder in the hydraulic steering system.

Thus, effectively, the fluid pressure does most of the steering work, while the driver controls the direction of the turn with the help of a very precise valve system.

ii) Explain MACHINING and HEAT TREATMENT for piston and liners:-

(Following relevant points to be consider for assessing answer=4marks

- Machining of piston
 - Open end bore machining
 - Rough outer diameter turning
 - Grooves forming
 - Semi finish hole boring
 - Circlip grooving oil hole drilling in 3rd groove and skirt
 - Ring grooving and chamfering
 - Final outer diameter turning
 - Deburring and cleaning
 - \succ Tin coating
 - Finish pin hole boring
- Heat treatment of piston:-Heat treatment of piston is controlled

Heating and cooling of metals to alter their physical and mechanical properties without changing the product shape, following process is carried out for piston



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- Toughening&
- Stress relieving
- Machining of liner
 - Rough boring
 - ➢ Fine boring
 - > Honing
 - > Polishing
- Heat treatment of liner
 - Carburizing (case hardening)
 - Stress relieving

Q 5

a) Construction and working of propeller shaft:
 (Answer should contain similar info and sketches. Explanation 2M and Sketches 2M)

Function

The purpose of the drive shaft and universal joints is to transmit the drive from the gearbox to the back axle with a smooth transmission of torque even though the gearbox and pinion shaft are never in exact alignment.

Construction

The shaft is a hollow tubular steel unit with a hook joint at each end. The joint consists of two u shaped 'yokes' which are connected at 90° to each other by a four-legged cross or 'spider'. Needle roller bearing may be used to support the spider legs in the yokes.



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Operating Principle

- When universal joints are used to connect two units (e.g. gearbox and back axle) the driven shaft does not rotate with uniform velocity i.e. it does not turn at the same speed during each part of a revolution
- In one revolution the driven shaft is accelerated twice and decelerated twice. This effect being increases as the angularity is increased. These velocity differences can be cancelled in the propeller shaft by the use of two correctly aligned joints, the acceleration of one being neutralised by the deceleration of the second.
- A sliding joint is used to allow the drive shaft to change its length as it rotates, to compensate for the small backward and forward movement of the rear axle caused by the action of the suspension system. It is simply a splined tubular portion built onto the forward universal joint and it slides in splines on the gearbox main shaft.

b) (Functions @1 MARKS EACH)

• Front wheels of the vehicle are mounted on front axles.

Functions of front axle are listed below :

- (a) It supports the weight of front part of the vehicle.
- (b) It facilitates steering.
- (c) It absorbs shocks which are transmitted due to road surface irregularities.
- (d) It absorbs torque applied on it due to braking of vehicle.



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- The rear axle mainly performs following two functions.
 - 1. It carries the weight of the vehicle.

2. It rotates and transmits the power from the engine to the wheels.

Applications: van, jeeps, trucks etc.

- c) Rigid axle suspension. (2M sketch 2 M Explanation)
 - Rigid axle suspension system consists of two longitudinal leaf springs on transverse spring in conjunction shock absorbers.
 - o These assemblies are mounted similarly to leaf spring suspensions..
 - Front wheel hub rotate on antifriction bearing on steering spindle attached to steering knuckles.



Solid Rear Axle Suspension



- d) Necessity of suspension system (@ 1M each point)
 - 1. To prevent the road shocks from being transmitted to the vehicle frame.
 - 2. To preserve the stability of the vehicle in pitching or vrolling.
 - 3. To safeguard the occupants from road shocks.



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- 4. To provide good road holding while driving, cornering and braking.
- e) Features and application of any two of the jigs.(2 Explanation 2 m sketch)
 Template Jig, Plate Type Jig, Open Type Jig, Swinging Leaf Type Jig, Box Type Jig, Solid
 Type Jig, Pot Type Jig, Index Jigs, Universal Jig.

f) Different types of fixtures are listed below. (any two types of fixtures, 2m Explanation 2 m sketch)

Turning fixtures (b) Milling fixtures (c) Fixture for grinding (d) Fixture for broaching (e) Fixture for boring/drilling (f) Tapping fixture (g) Fixture for welding (h) Assembling fixture.

Q 6

a)



- The clutch works on the principle of friction. When two friction surfaces are brought in contacts with each other and pressed they are united due to the friction between them. If one is revolved, the other will also revolve.
- The friction between the two surfaces depends upon the area of the surfaces, pressure applied upon them and coefficient of friction of the surface materials. The two surfaces can be separated and brought into contact when required.



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- One surface is considered as driving member and the other as driven member, the driving member is kept rotating.
- When the driven member is brought in contact with the driving member, it also starts rotating. When the driven member, it also starts rotating. When the driven member is separated from the driving member it does not revolve.

b) (1 M each definition and effect)

i) king pin inclination:

The angle between the vertical line and center of the king pin or steering axle, when viewed from the front of the wheel is known as steering axle inclination or **king pin inclination** (0-5 degrees for trucks and 10-15 degrees on passenger cars).



Effect:

• KPI helps the straight head recovery thus directional stability.

ii) Wheel toe-in is an angle formed by the centre line of the wheel and the longitudinal axis of the vehicle, looking at the vehicle from above, the sum of the toe values for each wheel gives the total toe value,

When the extensions of the wheel centre lines tend to meet in front of the direction of travel of the vehicle, this is known as toe-in , If, however the lines tend to meet behind the direction of travel of the vehicle, this is known as toe-out .





Effect:

Toe in/TOE OUT: General tendency of wheels is to toe out because of power full deviation from centre point steering. Hence to overcome this small amount of toe in is provided initially, such that wheel moves straight ahead in normal position.

c)

Classification of suspension system: Classification 2 M Application 2 M)

The Suspension system can be classified as given below,

 Solid Axle and independent suspension system. Independent suspension system is further classified as Macpherson, wishbone, Vertical guide, Trailing link, swinging half axle, air suspension (bellow type and piston type) type.

d) Design consideration of jig design.

(Relevant points to be considered min 8 points =4 marks) Important considerations while designing jigs;

Designing of jig depends upon so many factors. These factors are analysed to get design inputs for jigs. The list of such factors is mentioned below:



Model Answers

- i. Study of work piece and finished component size and geometry
- ii. Type and capacity of the machine, its extent of automation.
- iii. Provision of locating devices in the machine.
- iv. Available clamping arrangements in the machine.
- v. Available indexing devices, their accuracy.
- vi. Evaluation of variability in the performance results of the machine.
- vii. Rigidity and of the machine tool under consideration.
- viii. Study of ejecting devices, safety devices, etc.
- ix. Required level of the accuracy in the work and quality to be produced.
 - e) Two basic methods casting and forging, relevant manufacturing process should be elaborated.

(2M EACH METHOD)

Eg. Basic Steps of Manufacturing a Billet Crankshaft

- 1. Cutting to length and centering
- 2. · Turning
- 3. Turn broaching
- 4. \cdot Turn-turn broaching
- 5. · Internal milling
- 6. High speed external milling
- 7. \cdot Oil hole drilling
- 8. · Roller burnishing
- 9. \cdot End machining.