KATHMANDU UNIVERSITY
End Semester Examination
February, 2025

Marks Scored:

Level : B.E.
Year : III
Course : MEEG 318
Semester : II

Exam Roll No. :
Time: 30 mins.
F. M. : 10

Registration No.:
Date 18 FEB 2025

*Use of a Data Book is **NOT** allowed for the objective.*

SECTION "A"
[20 Q. × 1 = 10 marks]

*Choose the most appropriate answer and **mark [X].***

1. In material selection, which of the following factors is MOST critical for a component subjected to cyclic loading?
   [ ] Hardness
   [ ] Fatigue strength
   [ ] Toughness
   [ ] Thermal conductivity

2. In spur gears, the phenomenon of "undercutting" is most likely to occur when:
   [ ] The number of teeth is high
   [ ] The number of teeth is low
   [ ] The module is large
   [ ] The pressure angle is small

3. The Lewis form factor (Y) for a gear tooth depends on:
   i. Module
   ii. Pressure angle
   iii. Number of teeth
   iv. Gear thickness
   [ ] i, ii & iii
   [ ] ii, iii & iv
   [ ] iii, iv & i
   [ ] iv, i & ii

4. Which of the following gear types is most suitable for high-speed, high-power transmission with minimal noise?
   [ ] Spur gear
   [ ] Helical gear
   [ ] Bevel gear
   [ ] Worm gear

5. The efficiency of a worm gear drive is primarily limited by:
   [ ] Gear tooth wear
   [ ] Sliding friction
   [ ] Misalignment
   [ ] Surface roughness

6. In helical gears, the axial thrust load is directly proportional to:
   [ ] Module
   [ ] Helix angle
   [ ] Number of teeth
   [ ] Pitch circle diameter

7. Which of the following keys is most suitable for transmitting high torque in a reversible direction?
   [ ] Saddle key
   [ ] Feather key
   [ ] Woodruff key
   [ ] Gib-head key

8. The primary function of a flywheel in an engine is to:
   [ ] Reduce vibrations
   [ ] Store and release energy
   [ ] Increase engine speed
   [ ] Reduce fuel consumption

9. Which of the following friction materials is most suitable for high-temperature applications in clutches and brakes?
[ ] Asbestos [ ] Rubber [ ] Kevlar [ ] Ceramic

10. Which manufacturing process is most suitable for producing gears with high surface finish and dimensional accuracy?
[ ] Casting [ ] Forging [ ] Machining [ ] Welding

11. Which of the following couplings is most suitable for transmitting torque between misaligned shafts?
[ ] Oldhalm's coupling [ ] Universal coupling
[ ] Muff coupling [ ] Flange coupling

12. In a multi-plate clutch, the torque capacity is NOT directly proportional to:
[ ] Number of friction surfaces [ ] Coefficient of friction
[ ] Axial force [ ] Pressure plate thickness

13. Which of the following is a major DISADVANTAGE of using a cone clutch?
[ ] High cost [ ] Difficulty in maintaining alignment
[ ] Low torque capacity [ ] High wear rate

14. The primary purpose of a key in a shaft-hub connection is to:
[ ] Transmit torque [ ] Absorb shocks
[ ] Reduce vibration [ ] Increase efficiency

15. In shaft design, the Wahl factor is used to account for:
[ ] Bending stress due to radial load [ ] Stress concentration due to keyways
[ ] Torsional stress due to clutch [ ] Axial stress due to helical gear

16. In the design of a gear pair, the contact ratio is defined as:
[ ] The ratio of the number of teeth on the pinion to the gear
[ ] The ratio of the length of the path of contact to the base pitch
[ ] The ratio of the pitch circle diameter to the module
[ ] The ratio of the addendum to the dedendum

17. Which of the following is a primary DISADVANTAGE of using a worm gear drive?
[ ] High noise levels [ ] Low efficiency
[ ] High cost of manufacturing [ ] Limited load-carrying capacity

18. Which of the following is a primary ADVANTAGE of using a band brake over a block brake?
[ ] Higher braking torque [ ] Uniform wear distribution
[ ] Lower cost [ ] Simpler design

19. The primary objective of cost versus performance analysis in material selection is to:
[ ] Minimize cost only [ ] Maximize performance only
[ ] Optimize the balance between cost and performance [ ] Ignore material properties

20. The Lewis equation is used to calculate:
[ ] Gear tooth wear [ ] Gear tooth bending stress
[ ] Gear surface durability [ ] Gear heat dissipation

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Level : B.E.
Year : III
Time : 2 hrs. 30mins.

Course : MEEG 318
Semester : II
F. M. : 40

*Use of Data Book is **ALLOWED** for this examination.*

SECTION "B"
[4 Q. × 10 = 40 marks]

Attempt ALL questions. Assume and/or select suitable data if not specified.

1 a. You are an engineer tasked with selecting a coupling for a conveyor system that transports materials in a manufacturing plant. The system involves connecting a motor shaft to a conveyor drive shaft. The shafts are known to experience minor angular and parallel misalignment due to operational vibrations and structural shifts. The motor operates at a speed of 1200 rpm, transmitting a power of 10 kW. [3]

i. Based on your analysis, select a suitable flexible coupling type and justify your choice.

ii. Discuss any potential drawbacks of the chosen coupling and suggest possible mitigation strategies.

b. Design a spur gear that needs to transmit 10kW with an input speed of 1440 rpm. It has a gear ratio of 3:1 using material having an allowable stress of 120 MPa and a service factor of 1.5. Consider the gear to be under moderate shock and vibration.

i. Determine the minimum number of teeth for the pinion to avoid interference. [2]

ii. Calculate the module and pitch circle diameter for both gears. [2]

iii. Check the designed gears for bending and contact stress [3]

2 a. A helical gear has a normal module of 4 mm, 25 teeth, and a helix angle of 20°. Calculate the transverse module and the axial pitch [4]

b. Explain the phenomenon of temperature rise in clutches and brakes and its impact on performance. [3]

c. A multi-plate clutch has 3 contact surfaces, an outer diameter of 200 mm, and an inner diameter of 100 mm. If the coefficient of friction is 0.3 and the axial force is 500 N, calculate the torque capacity of the clutch. [3]

3 a. Discuss the role of keys in shaft-hub connections and the factors affecting key design. [2]

b. A solid circular shaft is subjected to a bending moment of 3000 N-m and a torque of 10000 N-m. The shaft is made of 45C8 steel having ultimate tensile stress of 700 MPa and ultimate shear stress of 500 MPa. Assuming a factor of safety as 6, determine the diameter of the shaft. [4]

c. A square key is used in the shaft from the above question. Find the dimensions of the key and check the key for its induced shearing and crushing stresses. [4]

P.T.O.

4 a. Given the following criteria, select the most appropriate material for constructing a bicycle frame: [3]

Criteria:

i. High strength-to-weight ratio
ii. Good corrosion resistance
iii. Cost-effectiveness for mass production
iv. Ease of manufacturing and availability

Explain your choice, justifying how the selected material meets each criterion considering Aluminum alloy, Carbon fiber, Steel Alloy, and Titanium as possible materials.

b. The dimensions of a pair of bevel gears are given in Figure 1. The gear G delivers 7kW of power at 300 rpm to the output shaft. The pressure angle is 20°. The thrust load is borne by a deep groove ball bearing at C and the length of teeth along the cone in the gear is 20mm.

i. Calculate the tangential, radial, and axial components of the resultant tooth force acting on the pinion. [3]
ii. Draw a free-body diagram of forces acting on the pinion and the gear. [2]
iii. Calculate the resultant forces on the bearings C and D. [2]

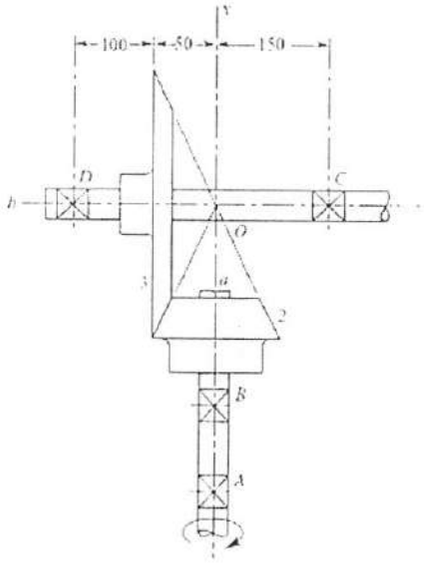

Figure 1: Bevel gear setup (*All dimensions are in mm)*

OR

The design of the type flywheel is to be carried out for the punching press machine with the condition that the diameter of the flywheel should not exceed 1.4 m. The flywheel is to be designed to punch 20 mm diameter holes in a steel plate of 20 mm thickness at the rate of 30 holes/minute. The punching operation takes place during 1/10th of a revolution of the crankshaft. The force-displacement curve during punching can be assumed to be triangular. The flywheel is to revolve at 9 times the speed of the crankshaft. Assume that the rim contributes 90% of the required moment of inertia. In concern this geometrical dimension, material, and function values of the flywheel as stated below: [7]

i. Ultimate shear strength of Steel Plate = 320 Mpa
ii. Coefficient of fluctuation of speed = 0.2
iii. Flywheel Material: Cast iron with a density of 7300 kg/m3 and working stress (tensile) of 6 Mpa