Escola Tècnica Superior d'Enginyers de Camins, Canals i Ports de Barcelona
UNIVERSITAT POLITÈCNICA DE CATALUNYA

Department of Civil Engineering
Transportation and Territory Group

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Transportation Planning and Management on the Territory

MEng in Civil Engineering

Course 2015-16, group 20, quarter Q2 (June 2, 2016)

Modeling (M)

TIME: **90 MIN**.

WITHOUT DOCUMENTS, CLASS NOTES, ABSTRACTS, ETC. **WITHOUT MOBILE PHONES**, iPADS, iPODS, iNOTHING, AND NO OTHER ELECTRONIC DEVICES. JUST SIMPLE CALCULATORS WITHOUT FORMULAS, PROGRAMS/ROUTINES OR TEXT STORED IN THE MEMORY.

WRITE DOWN YOUR **FULL NAME** CLEARLY INCLUDING **ID/PASSPORT** AND **SIGN** THIS EXAMINATION SHEET. **WRITE DOWN YOUR NAME IN THE QUESTIONS MARKED** (THEY WILL BE GRADED BY DIFFERENT PROFESSORS: PARALLEL PROCESSING SHORTENS THE GRADING TIME).

PLEASE ANSWER ON THESE ANSWER SHEETS (MORE SHEETS IN BLANK WILL BE DELIVERED JUST FOR SCRATCH CALCULATION OR NOTES).

Remember Pareto's **ABC Rule**: 80% of the grade can be reached by the 20% of the time and effort. Answer first the questions you know AND they have the maximum weight: this will give you the maximum grade per allocated time. Part of the grade consists on demonstrate the knowledge and the other part measures decision making process under time pressure.

Student: _____.

ID/Passport = _____.

Signature:

This is a REAL exam of THEORY that took place in a previous course. If you take it seriously (solve it in only 90 minutes of concentration, alone by yourself, without looking at the course notes), and you compare your solution with the solution given in the Powerpoint, you can get a good feeling of how you are learning the concepts that we pretend to transmit.

Contents between courses may vary a little bit. We usually ask questions about what we taught in class during the course.

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THEORY (90min)

1. PRICING - MICROECONOMICS (20%).

For a highway entering a city, the user's cost supply function (in tens of euros) as a function of the traffic flow q (in thousands of cars/hour) is given by: 5 for $q<1$, and $5 + (q-1)^2$ for $q \geq 1$. The demand curve is given by $q(p)=5-p/6$, where p is the price.

Answer:

Draw the supply and demand curves:

Analytical expression of the marginal costs (as a function of q):

Draw the marginal cost curve on the previous figure.

Values of the traffic flow and the cost for the current equilibrium:

$q^*=$ _____, $c^*(q)=$ _____.

Analytical expression of Pigou's tax to reach the social optimum:

Value of Pigou's tax in order to reach the social optimum: _____.

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2. OPERATIONS - QUEUES (20%)

Buses depart every h min from a bus depot but they alternatively go to two different final destinations 1 and 2 after sharing the same urban corridor for a while. At the bus depot arrive λ_1 pax/min that take only buses that go to destination 1, λ_2 pax/min that take only buses that go to destination 2, and λ_3 pax/min that can use both routes (they go to some point of the common corridor).

Answer:

Draw the queueing diagram:

Calculate the number of passengers that take the bus going to 1:

Calculate the average waiting time for all the passengers that take bus going to destination 1:

Calculate the average waiting time per passenger at the bus depot:

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3. APPRAISAL (20%)

Answer:

Analytically define the Net Present Value (NPV) indicator for cost-benefit analysis in the case of CONTINUOUS TIME (warning! Do NOT include any subindex "k"!!!):

Assume the benefits b(t) minus the costs c(t) are constant independently of the time: b(t)-c(t)=d. For the following value of the investment I, analytically calculate the NPV:

$$I = \frac{d}{r}\, e^{-rT}$$

For this particular case, analytically calculate the IRR (Internal Rate of Return):

For this particular case, analytically calculate the investment recovery period:

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4. DEMAND (10%).

For a given pair of origin-destinations in a city there are only two modes, car and bus. Mode choice is based only in travel times (attribute). The parameter that translates travel times into measurable utility is θ = -0.02 min^{-1}. If we know that the observed modal split is 2/3 for the car, and 1/3 for the bus, and the travel time for the bus is t_b= 50min, calculate the average travel time for the car t_c using a logit model.

Answer:

5. MICROECONOMICS (10%)

Analytically prove that by reducing the transit (public transportation) fares, the transit operator always reduces profits.

Answer:

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6. CITY LOGISTICS (10%)

Answer:

Prove the sub-additivity property of the Traveling Salesman Problem:

List five city logistics policies:

-

-

-

-

-

How to improve freight delivery to bars?

Explain the unassisted off-hour delivery in New York:

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Student's full name: _____

7. TRAFFIC MANAGEMENT (10%)

Explain how traffic emissions can be computed. Your answer should include:

Explain how traffic emissions can be computed. Your answer should include: One equation: List of factors affecting each parameter / variable of the previous equation: Enumerate some strategies / policies to reduce the contribution to traffic emissions of each of the previous parameters / variables

PLEASE CHECK THAT YOU PUT YOUR NAME ON THE TOP OF THIS PAGE AGAIN.