INSTRUCTIONS:
Fill out the hazard analysis and risk assessment below.
HA-001 should be for the lane departure warning function as discussed in the lecture.
HA-002 should be for the lane keeping assistance function as discussed in the lecture.
Then come up with your own situations and hazards for the lane assistance system. Fill in the HA-003 and HA-004 rows.
When finished, export your spreadsheet as a pdf file so that a reviewer can easily see your work.

Hazard ID	Situational Analysis				
	Operational Mode	Operational Scenario	Environmental Details	Situation Details	Other Details (optional)
HA-001	normal driving	highway	rain (slippery mode)	high speed	
HA-002	normal driving	country road	normal conditions	high speed	
HA-003	normal driving	highway	normal conditions	high speed	
HA-004	normal driving	highway	normal conditions	high speed	

Item Usage (function)	Situation Description	Function	Deviation	Deviation Details
correctly used	Normal driving on a highway during rain (slippery road) with high speed and correctly used system.	Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver with haptic feedback	Too much vibration	LDW function applies oscillating torque with very high torque (above limit)
incorrectly used	Normal driving on a country road during normal conditions with high speed and incorrectly used system.	Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane	Always on	Driver treats lane assistance as full autonomy.
correctly used	Normal driving on a highway during rain (slippery road) with high speed and correctly used system.	Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane	Too much steering correction	Too much steering correction can result in car oscillation, especially at high speeds.
incorrectly used	Normal driving on a highway during normal conditions with high speed and incorrectly used system.	Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver with haptic feedback	Not activated	Driver inattentive due to assumption that LDW function will warn about all hazards. Next hazard may be obstacle or vehicle that LDW cannot warn about.

Hazard Identification

Hazardous Event (resulting effect)	Event Details	Hazardous Event Description	Exposure (of situation)	Rationale (for exposure)
collision with other vehicle	High haptic feedback can affect driver's ability to steer as intended. The driver could lose control of the vehicle and collide with another vehicle or with road infrastructure.	LDW function applies too much oscillating torque to steering wheel (above limit).	E3	Highway driving would normally be E4 (very common). Rain slightly reduces the exposure (to E3) because only a small portion of highway driving is in combination with rain.
collision with other vehicle	Inattentive driver may not notice other vehicles.	Driver treats lane keeping function as autonomous function and takes hands off the wheel, which could result in a collision with other cars.	E2	Misusing while on country road is unusual combination.
collision with other vehicle	Severe oscillation can result in car leaving the lane or startling other drivers, leading to a collision.	LK system oversteers, leading to oscillations and possibly collision.	E4	Typical highway driving is common.
collision with other vehicle	Inattentive driver may not notice other vehicles.	Driver overly reliant on LDW and looks away from the road, which could result in a collision with other cars.	E2	Misuse will be brief because over-relying on LDW will quickly result in haptic feedback and need to look at the road for correction.

Hazardous Event Classification				Determin
Severity (of potential harm)	**Rationale (for severity)**	**Controllability (of hazardous event)**	**Rationale (for controllability)**	**ASIL Determination**
S3	High speed collisions can be fatal.	C3	Strong vibrations cause uncontrollable swerving.	C
S3	High speed collisions can be fatal.	C3	Driver's hands not on wheel, so control is impossible.	B
S3	High speed collisions can be fatal.	C3	Car oscillations can directly and immediately cause a collision, leaving the driver without time to react.	D
S3	High speed collisions can be fatal.	C3	Driver's eyes not on the road, so control is impossible.	B

nation of ASIL and Safety Goals
Safety Goal
The oscillating steering torque from the lane departure warning function shall be limited.
The lane keeping assistance function shall be time limited and the additional steering torque shall end after a given time interval so that the driver cannot misuse the system for autonomous driving.
The steering torque from the LK function shall be limited.
The haptic warning shall be triggered by the driver closing eyes or looking away (other than quick blind spot check).

EXAMPLE DISCUSSED IN THE PROJECT INSTRUCTIONS - Headlamp System

Hazard ID		
	Operational Mode	**Operational Scenario**
HA-001	Normal Driving	City Road

MORE EXAMPLES - Headlamp System

Hazard ID		
	Operational Mode	**Operational Scenario**
HA-001	OM03 - Normal Driving	OS01 - City Road
HA-002	OM03 - Normal Driving	OS01 - City Road
HA-003	OM03 - Normal Driving	OS03 - Highway
HA-004	OM03 - Normal Driving	OS02 - Country Road
HA-005	OM03 - Normal Driving	OS02 - Country Road

Situational Analysis			
Environmental Details	**Situation Details (optional)**	**Other Details (optional)**	**Item Usage (function)**
Normal Conditions	Low Speed	Night time + Obstacle on the	Correctly Used

Situation Analysis			
Environmental Details	**Situation Details (optional)**	**Other Details (optional)**	**Item Usage (function)**
EN01 - Normal conditions	SD03 - Low speed	Night time + Obstacle on the	IU01 - Correctly used
EN04 - Snowfall (degraded view)	SD03 - Low speed	Night time + Obstacle on the	IU01 - Correctly used
EN04 - Snowfall (degraded view)	SD03 - High speed	Night time + Obstacle on the	IU01 - Correctly used
EN01 - Normal conditions	SD02 - High speed	Night time + Oncoming	IU01 - Correctly used
EN04 - Snowfall (degraded view)	SD04 - High speed	Night time + Obstacle on the	IU01 - Correctly used

Situation Description	Function	Deviation
Normal Driving on a City Road in Normal	Low beam illuminates the	Function not activated

Situation Description	Function	Deviation
Normal Driving on City Road during Normal	Low beam illuminates the	DV01 - Function not activated
Normal Driving on City Road during Snowfall	Low beam illuminates the	DV01 - Function not activated
Normal Driving on Highway during Snowfall	Low beam illuminates the	DV01 - Function not activated
Normal Driving on Country Road during Normal	Low beam illuminates the	DV01 - Function not activated
Normal Driving on Country Road during Snowfall	Low beam illuminates the	DV01 - Function not activated

Hazard Identification			
Deviation Details	**Hazardous Event (resulting effect)**	**Event Details**	**Hazardous Event Description**
Both headlights stop working	Front collision with obstacle	Vehicle crashes into the	Total loss of low beam

Hazard Identification			
Deviation Details	**Hazardous Event (resulting effect)**	**Event Details**	**Hazardous Event Description**
Both headlights stop working	EV04 - Front collision with obstacle	Vehicle crashes into the	Total loss of low beam
Both headlights stop working	EV04 - Front collision with obstacle	Vehicle crashes into the	Total loss of low beam
Both headlights stop working	EV04 - Front collision with obstacle	Vehicle crashes into the	Total loss of low beam
Both headlights stop working	EV08 - Collision with other vehicle	Vehicle crashes into the	Total loss of low beam
Both headlights stop working	EV04 - Front collision with obstacle	Vehicle crashes into the	Total loss of low beam

Hazardous		
Exposure (of situation)	**Rationale (for exposure)**	**Severity (of potential harm)**
E4 - High probability	night driving in the city is a regular	S1 - Light and moderate injuries

Hazardous		
Exposure (of situation)	**Rationale (for exposure)**	**Severity (of potential harm)**
E4 - High probability	night driving in the city is a regular	S1 - Light and moderate injuries
E1 - Very low probability	night driving in the city on	S1 - Light and moderate injuries
E2 - Low probability	High driving is part of regular	S3 - Life-threatening or fatal injuries
E4 - High probability	country driving is part of regular	S3 - Life-threatening or fatal injuries
E2 - Low probability	country driving is part of regular	S3 - Life-threatening or fatal injuries

s Event Classification

Rationale (for severity)	Controllability (of hazardous event)
In city traffiic, speed of vehicle is expected to be low	C0 - Controllable in general

s Event Classification

Rationale (for severity)	Controllability (of hazardous event)
In city traffiic, speed of vehicle is expected to be low	C0 - Controllable in general
In city traffiic, speed of vehicle is expected to be low	C1 - Simply controllable
On highway speed of vehicle is expected to be high	C2 - Normally controllable
On country roads speed of vehicle is expected to be high	C1 - Simply controllable
On country roads speed of vehicle is expected to be high	C3 - Difficult to control or uncontrollable

	Determination of ASIL and Safety Goals	
Rationale (for controllability)	**ASIL Determination**	**Safety Goal**
At city speed, most drivers will be able to	QM	Total Loss of Beam Shall

	Determination of ASIL and Safety Goals	
Rationale (for controllability)	**ASIL Determination**	**Safety Goal**
At city speed, most drivers will be able to	QM	Total loss of low beam
On completely unilluminated city roads,	QM	Total loss of low beam
When driving on highway with low beam, it	A	Total loss of low beam
Since there is usually no other form of	B	Total loss of low beam
Since there is usually no other form of	B	Total loss of low beam

Hazard & Risk Analysis Definiti

Operational Mode

ID	Mode
OM01	Parked
OM02	Ignition on
OM03	Normal driving
OM04	Backward driving
OM05	Degraded driving
OM06	Towing (active)
OM07	Towing (passive)
OM08	Service
OM09	N/A

Operational Scenario

ID	Scenario
OS01	Any Road
OS02	City Road
OS03	Country Road
OS04	Highway
OS05	Mountain Pass
OS06	Off Road
OS07	Road with gradient
OS08	Road with bump
OS09	Road tunnel
OS10	Road with construction site
OS11	N/A

Situation Details

ID	Scenario
SD01	Low speed
SD02	High speed
SD03	Normal acceleration
SD04	High acceleration
SD05	Normal braking
SD06	High braking
SD07	N/A

Item Usage

ID	Mode
IU01	Correctly used
IU02	Incorrectly used
IU03	N/A

Environmental Details

ID	Scenario
EN01	Normal conditions
EN02	Sun blares (degraded view)
EN03	Fog (degraded view)
EN04	Snowfall (degraded view)
EN05	Cross-wind (lateral force)
EN06	Rain (slippery road)
EN07	Snow (slippery road)
EN08	Glace (slippery road)
EN09	N/A

Definitions

Remarks
Car is parked, ignition is off
Car is parked, ignition is on
Car is driving
Car is driving
Limp home mode
Towing another car
Beeing towed by another car
Vehicle is in repair garage
not applicable or not relevant

Remarks
road type
road type
road type
road type
road type
road type
road attribute
road attribute
road attribute
road attribute
not applicable or not relevant

Remarks
driving attribute
driving attribute
driving attribute
driving attribute
driving attribute
driving attribute
not applicable or not relevant

Remarks
Intended usage
Unintended usage (foreseeable)
not applicable or not relevant

Remarks
weather attribute
weather attribute
weather attribute
weather attribute
weather attribute
road attribute
road attribute
road attribute
not applicable or not relevant

Reference
OM01 - Parked
OM02 - Ignition on
OM03 - Normal driving
OM04 - Backward driving
OM05 - Degraded driving
OM06 - Towing (active)
OM07 - Towing (passive)
OM08 - Service
OM09 - N/A

Reference
OS01 - Any Road
OS02 - City Road
OS03 - Country Road
OS04 - Highway
OS05 - Mountain Pass
OS06 - Off Road
OS07 - Road with gradient
OS08 - Road with bump
OS09 - Road tunnel
OS10 - Road with construction site
OS11 - N/A

Reference
SD01 - Low speed
SD02 - High speed
SD03 - Normal acceleration
SD04 - High acceleration
SD05 - Normal braking
SD06 - High braking
SD07 - N/A

Reference
IU01 - Correctly used
IU02 - Incorrectly used
IU03 - N/A

Reference
EN01 - Normal conditions
EN02 - Sun blares (degraded view)
EN03 - Fog (degraded view)
EN04 - Snowfall (degraded view)
EN05 - Cross-wind (lateral force)
EN06 - Rain (slippery road)
EN07 - Snow (slippery road)
EN08 - Glace (slippery road)
EN09 - N/A

Deviation

ID	Deviation (Guideword)	Remarks
DV01	Function not activated	Activation error
DV02	Function unexpectedly activated	Activation error
DV03	Function always activated	Activation error
DV04	Actor effect is too much	Quantitative error
DV05	Actor effect is too less	Quantitative error
DV06	Actor action too early	Timing error
DV07	Actor action too late	Timing error
DV08	Actor action before	Sequence error
DV09	Actor action after	Sequence error
DV10	Actor effect is reverse	Logical error
DV11	Actor effect is wrong	Logical error
DV12	Sensor sensitivity is too high	Quantitative error
DV13	Sensor sensitivity is too low	Quantitative error
DV14	Sensor detection too early	Timing error
DV15	Sensor detection too late	Timing error
DV16	Sensor detection before	Sequence error
DV17	Sensor detection after	Sequence error
DV18	Sensor detection is reverse	Logical error
DV19	Sensor detection is wrong	Logical error
DV20	N/A	not applicable or not relevant

Hazardous Events (possibe effects)

ID	Hazardous Event	Remarks
EV-07	None	
EV-06	Front collision with oncoming traffic	
EV-05	Front collision with ahead traffic	
EV-04	Front collision with obstacle	
EV-03	Rear collision with trailing traffic	
EV-02	Side collision with other traffic	

EV-01	Side collision with obstacle	
EV00	Collision with other vehicle	
EV01	Collision with train	
EV02	Collision with pedestrian	
EV03	Car spins out of control	
EV04	Car comes off the road	
EV05	Car catches file	
EV06	N/A	

Reference
DV01 - Function not activated
DV02 - Function unexpectedly activated
DV03 - Function always activated
DV04 - Actor effect is too much
DV05 - Actor effect is too less
DV06 - Actor action too early
DV07 - Actor action too late
DV08 - Actor action before
DV09 - Actor action after
DV10 - Actor effect is reverse
DV11 - Actor effect is wrong
DV12 - Sensor sensitivity is too high
DV13 - Sensor sensitivity is too low
DV14 - Sensor detection too early
DV15 - Sensor detection too late
DV16 - Sensor detection before
DV17 - Sensor detection after
DV18 - Sensor detection is reverse
DV19 - Sensor detection is wrong
DV20 - N/A

Reference
EV-07 - None
EV-06 - Front collision with oncoming traffic
EV-05 - Front collision with ahead traffic
EV-04 - Front collision with obstacle
EV-03 - Rear collision with trailing traffic
EV-02 - Side collision with other traffic

EV-01 - Side collision with obstacle
EV00 - Collision with other vehicle
EV01 - Collision with train
EV02 - Collision with pedestrian
EV03 - Car spins out of control
EV04 - Car comes off the road
EV05 - Car catches file
EV06 - N/A

Exposure

ID	Description	Duration (of situation)
E0	Incredible	
E1	Very low probability	Not specified
E2	Low probability	<1 % of average operating time
E3	Medium probability	1 % to 10 % of average operating time
E4	High probability	>10 % of average operating time

Severity

ID	Description	Remarks
S0	No injuries	No injuries
S1	Light and moderate injuries	Light and moderate injuries
S2	Severe and life-threatening injuries	Severe and life-threatening injuries (survival probable)
S3	Life-threatening or fatal injuries	Life-threatening injuries (survival uncertain), fatal injuries

Controllability

ID	Description	Remarks
C0	Controllable in general	Controllable in general
C1	Simply controllable	99 % or more of all drivers or other traffic participants are usually able
C2	Normally controllable	90 % or more of all drivers or other traffic participants are usually able
C3	Difficult to control or uncontrollable	Less than 90 % of all drivers or other traffic participants are usually ab

Frequency (of situation)	Reference
	E0 - Incredible
Occurs less often than once a year for the great majority of drivers	E1 - Very low probability
Occurs a few times a year for the great majority of drivers	E2 - Low probability
Occurs once a month or more often for an average driver	E3 - Medium probability
Occurs during almost every drive on average	E4 - High probability

Probability of Injuries	Reference
AIS 0 and less than 10 % probability of AIS 1-6	S0 - No injuries
More than 10 % probability of AIS 1-6 (and not S2 or S3)	S1 - Light and moderate injuries
More than 10 % probability of AIS 3-6 (and not S3)	S2 - Severe and life-threatening injuries
More than 10 % probability of AIS 5-6	S3 - Life-threatening or fatal injuries

	Reference
	C0 - Controllable in general
usually able to avoid harm	C1 - Simply controllable
usually able to avoid harm	C2 - Normally controllable
e usually able, or barely able, to avoid harm	C3 - Difficult to control or uncontrollable

Controllability	Exposure	Severity			
		S0	S1	S2	S3
C1	E1	QM	QM	QM	QM
	E2	QM	QM	QM	QM
	E3	QM	QM	QM	A
	E4	QM	QM	A	B
C2	E1	QM	QM	QM	QM
	E2	QM	QM	QM	A
	E3	QM	QM	A	B
	E4	QM	A	B	C
C3	E1	QM	QM	QM	A
	E2	QM	QM	A	B
	E3	QM	A	B	C
	E4	QM	B	C	D